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I certify that I have read the transcript for the March 29, 2007, meeting of the Panel, and that, to the best of my knowledge, this transcript is accurate and complete.

Linda Zeiler, Designated Federal Officer

Dr. Jan M. Mutmansky, Chair

TRANSCRIPT OF PROCEEDINGS

IN THE MATTER OF:	)
	)
TECHNICAL STUDY PANEL ON THE	)
UTILIZATION OF BELT AIR AND THE	)
COMPOSITION AND FIRE RETARDANT	)
PROPERTIES OF BELT MATERIALS	)
IN UNDERGROUND COAL MINING	)

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UNITED STATES DEPARTMENT OF LABOR
MINE SAFETY AND HEALTH ADMINISTRATION

IN THE MATTER OF:)
)
TECHNICAL STUDY PANEL ON THE)
UTILIZATION OF BELT AIR AND THE)
COMPOSITION AND FIRE RETARDANT)
PROPERTIES OF BELT MATERIALS)
IN UNDERGROUND COAL MINING)

Glenwood Room
Holiday Inn
Pittsburgh Airport
8256 University Blvd
Coraopolis, Pennsylvania

Thursday,
March 29, 2007

The parties met, pursuant to the notice, at 9:10 a.m.

BEFORE: LINDA F. ZEILER
Designated Federal Officer

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P R O C E E D I N G S

(9:10 a.m.)

MS. ZEILER: Good morning. I think we are ready to start. I have one announcement. If you have not signed in this morning, if you please could at some point. Even if you were here yesterday, you need to sign in for attendance today. Thanks.

We are going to start out this morning with kind of a completion of the discussion of flammability testing. Harry Verakis from MSHA is going to give a presentation on MSHA laboratory scale flammability testing. Harry.

MR. VERAKIS: Good morning. Before I get into my presentation, there were a couple of things that came up yesterday, and one of the questions was from Jim Weeks. When Dr. Lazzara was making his presentation, you mentioned about the 2G test, MSHA's acceptance test, and what purpose did it serve.

If you go back -- and remember in the first meeting that I talked about the development of testing for fire resistant belting, and the incident that happened in Great Britain, the Creswell fire, which killed 80 miners, and then the British got into developing tests for fire resistant belting, and then of course the U.S. got in at that time, too.

And what the 2G or now the 18.65 test resulted in was getting rid of the highly flammable rubber belts. That's really what the purpose was of it.

But you could see from presentations that were made yesterday and work that has been done overall -- I mean, there are other tests that are up here as far as fire resistance high, and the 2G is down near the bottom.

DR. WEEKS: Near the bottom.

MR. VERAKIS: Basically at the bottom, in terms of fire resistance, compared to the other tests, like the British have, the propane gallery test.

DR. WEEKS: Do you think that there is a need for more rigorous testing?

MR. VERAKIS: I think you have plenty of rigorous testing that has been done. I mean, you look at the work that has been done at Lake Lynn. A lot of tests done at Lake Lynn on a large scale.

DR. WEEKS: Right.

DR. WEEKS: I was thinking in terms of --

MS. ZEILER: Jim, could you please pull the microphone over? Thanks.

DR. WEEKS: Sure. I was thinking in terms of regulations requiring more rigorous testing, and requiring that. And where the question came from for Chuck was that we have seen fires that have occurred in mines, and those belts had passed the tests, and the question arose that what failed if they had passed the test, and what does that mean as far as reasonable expectations.

And it seems to me that if a belt passed a test for flammability, then we should not expect fires from that belt, but that happened, and so that is where that question came from.

MR. VERAKIS: Yes. Now in fires that have occurred -- and not in every instance, but in some of the instances, we get samples of the belt from a fire incident, and we run the 2G test on them.

There are a number of times, and many times really, when the belt passes that test. There are sometimes when it does not.

DR. WEEKS: What can we expect from a belt that passes the test?

MR. VERAKIS: Basically what you can expect is what the criteria for that test is. It is based upon that particular test and what that criteria is for that belt to pass that test.

DR. WEEKS: Well, there aren't many propane lamps underneath belts in coal mines. So the question is whether or not that simulates real conditions in a mine.

MR. VERAKIS: The 2G test?

DR. WEEKS: Yes.

MR. VERAKIS: I never came across any data that showed large scale testing before the 2G test was developed. Here is a body of data from large scale testing, regardless of what kind of large scale testing it was, and here is a body of data from a large scale test work, and from that test work here is the 2G test, which was developed, and I have never seen that body of data.

DR. WEEKS: Well, a good response to the fire testing and the 2G test, but that was 50 years ago, and can we do better now is the question, and I think that is the question that I think we have to try to answer.

MR. VERAKIS: Yes, I think that is part of this whole process, is that is the purpose. When I get into my presentation, I will talk a little bit about developing tests, and what it takes to get some of these tests done.

MR. MUCHO: You mentioned a point, Harry, that I would like to get clarified. You say sometimes from belt incidents of fires in the U.S. that you get samples back to Approval and Certification, and you run the 2G test on them.

And you said that in some instances you will find that they don't pass the 2G from the actual belt that was involved in the fire. So, I assume the 2G -- and this is an assumption, and correct me if I am wrong -- the 2G is fairly repeatable.

When you sample a type of belt for approval, it is fairly repeatable and you get the same result; is that correct?

MR. VERAKIS: That is a difficult question to answer, because you have such a variety of belts and you have a belt that comes out of a mine from a fire, it could be a warning on what the extent of the wear is. Repeatability in fire testing is a difficult thing to get the same answer.

You know, it is not like a chemical analysis, and where you hope to get the same answer all the time. I mean, you are dealing with dynamic phenomena. So, repeatability, you don't expect in the 2G test to take a sample and get the same number every time.

And in my presentation, I will talk about that as far as the BELT test goes. One of the things that we did with the 2G test quite some time ago was to try to come up with a standard material, where we could run this standard material before we actually ran the test, to make sure that things were where they were supposed to be, and you had things set up properly.

I could not come up with a standard, a so-called standard material, that I got the same number every time. There is variations in it.

MR. MUCHO: Well, where I was headed really was quality control. Is in some instances quality control an issue, and I think if I understand what you are saying, it is more often probably the belt and the conditions that it was exposed to during its time and use in the mine, and are factors which would contribute to the results of the 2G test, or failing a 2G test; is that correct?

MR. VERAKIS: Yes, those can be factors.

MR. MUCHO: I take it that you don't see much of a problem in terms of quality control of belts that you see getting back from mines, and at least in starting out, you think they are the same as belts that were tested originally to give the approval?

MR. VERAKIS: Yes. One of the other things, too, is that there was mention yesterday about oxygen index testing. Oxygen index testing is a type of quality control test.

You will get a number, and it is a fairly repeatable test, and we even looked at the oxygen index test back when we were doing development work as a possibility for quality control. And I know that other organizations do use it for that purpose.

DR. WEEKS: There are other factors that are important in testing. For example, frictional ignitions are a very common pathway to starting a fire and testing for frictional ignitions with belts. The other issue is --

MS. ZEILER: I'm sorry, Jim, but could you just move that microphone a little closer. Thanks.

DR. WEEKS: And the other issue is smoke density, and that is a factor in a mine in terms of escape, and so those are a couple of things that come up as potential issues that we are concerned with, in terms of mine safety, which the 2G has --

MR. VERAKIS: The 2G test is basically an ignition type test. You don't get propagation values from 2G tests like Dr. Lazzara talked about yesterday. One other thing that I want to make, too, because this has been brought up -- it was brought up at the first meeting, and it was brought up yesterday in the NIOSH presentation about fire suppression work.

Fire suppression work is ongoing. We have a program with NIOSH, in partnership with NIOSH, that we are working on to look at fire suppression systems on conveyor belts, and then part of the reason is how well do fire suppression systems work.

We are starting to look at dry powder, dry chemical systems, and what the effect of air flow is concerning those systems, because you are dealing with belt air, and how does that affect a fire suppression system when it goes off.

So we have a program working with NIOSH to evaluate that on a large scale, and we have a 50 foot conveyor structure, with a length of belting, six foot wide belting, and we are simulating a drive drum system, and putting in fire suppression systems on this conveyor system and see what happens in covering that 50 feet and how these things work.

So we are at the point of starting that. I mean, it is an ongoing project, and we are not at the point of providing data at this time. But that will come.

MR. MUCHO: Is that just with dry powder or are you going to look at water systems, too?

MR. VERAKIS: We want to look at water systems, too.

MR. MUCHO: Currently that has been dry powder?

MR. VERAKIS: Pardon?

MR. MUCHO: What has been done currently is dry powder?

MR. VERAKIS: Yes, we started out using or working with dry powder.

MR. MUCHO: Yesterday it was stated that there were some issues with high velocities with dry powder systems?

MR. VERAKIS: Yes. I mean, it was mentioned about VP-8.

MR. MUCHO: Right, dry powder.

MR. VERAKIS: Yes. I am going to give you an overview of what I am going to talk about. I am going to talk about the timeline from 1989 to 2002. Dr. Lazzara talked about the research work and brought it up to 1989, and I am going to talk about the belt test program that we had, and then I will talk some on the rulemaking that we were into.

I will talk a bit about the mid-scale test development, and what went into doing that, and a voluntary belt test program that we had set up, and what some of the results were of that belt test program.

And then concurrent with the belt test program, and following subsequent rulemaking, what went on there. Just to kind of sum things up, as Dr. Lazzara talked about yesterday, we had a large scale fire test, and they were made over a range of air flows.

We went from no air flow on up to around 1,200 feet per minute. We got quite a bit of data from the large scale tests, but even prior to the large scale tests, we did a lot of small scale test work.

We took the 2G apparatus, and it is run at 300 feet per minute. We took that apparatus and we ran it with no air flow to see what happens. If we didn't have any air flow in the passageway, then how does the belt burn.

And we collected data with no airflow, and made modifications. We also even looked at a German tunnel test apparatus, and we did a lot of work there, and we got data from that.

But when we got into the large scale test, and what happened with the small scale test work, is that you have that test and you have this test. I mean, where do you draw the line, and how do you know what is good, and what is not so good, and that was the difficulty.

And you make changes to the test and you get data, but what does that data mean. How can you use that data, and that is where our problem was, and what we said was that we need to go large scale. We need to see what is happening on a large scale, and of course at the same time there was the belt air issue and air velocities.

So we did two things. We were collecting data to develop a small scale test, and also to look at what the effect of air flow was. And, of course, Dr. Lazzara talked about developing the new mid-scale test for fire resistant conveyor belting, and I will get into that in more detail.

But what goes into this mid-scale type of test, and what you need to do, is when you have scaling in a test, you have got a large scale test scale, a large Lake Lynn scale testing, and you want to take it down to something smaller that is workable, because large scale testing takes a lot of time, and takes a lot of effort, and takes a lot of money. It is very expensive.

You have to consider the type, and the strength, and the location of the ignition emission source, and the kind of ignition emission source that you are going to have, and Dr. Lazzara talked about a couple of different ignition sources.

He talked about the fuel tray, and he talked about the coal pile; and what about the size and the location of the test sample? Are you going to have a large test sample or are you going to have a small test sample? What are you going to have?

And that was shown yesterday in the Phoenix presentation about different sizes of belts for different types of tests, and what are the air flow conditions going to be.

Are you going to run it at no air flow, 300 feet per minute, a thousand feet per minute? Well, what Dr. Lazzara showed yesterday was 300 feet per minute, and the large scale work at Lake Lynn was optimum.

And you have to consider the material, and what is the test apparatus going to be constructed of. What kind of materials, because that plays a role, too.

What we wanted with the mid-scale test was we wanted to come up with a test that gave comparable results with the large scale tests, so that we had some kind of scientific basis for the test that is being developed.

So we used the large scale test results for that purpose. One was for the test apparatus to be easy to construct, and so that it is not time consuming to build a test apparatus.

We want it to be simple to operate, and the more complicated that it gets to operate a test apparatus, the more difficulty you can have with the apparatus, and the more things you have to go over. So you try to simplify the operation of the apparatus.

And, of course, you want it to be repeatable. Is it a good test, you know. Then you have to get into the cost. I mean, do you want a hundred-thousand dollar test, or do you want something that is more reasonable than that.

Okay. The time line, 1989, when the Bureau of Mines came up with the mid-scale test, we felt that we needed to have a public meeting. We had a public meeting at the MSHA Approval and Certification Center to talk about the results, and that was held on January 19, 1989.

And we discussed MSHA and the Bureau of Mines' large and small scale belt flammability test work, and went into the details, and talked about the Lake Lynn program, and talked about the development of the mid-scale test, and talked about the small scale test work that we had done.

Then we presented what is MSHA going to do and what are our future plans for this conveyor belt testing. We now have this mid-scale test, and what are we going to do.

So we decided, well, we will have a voluntary program and we believe that this mid-scale test is something that we can get into rulemaking with. So what is the mid-scale test going to do? Our intent was to take the 2G test or the 18.65 test and replace it.

And what are we going to replace it with? We are going to replace it with the test that the Bureau of Mines developed based upon the Lake Lynn work.

So we came up with a voluntary test program, and we instituted this test program at the Approval and Certification Center using the mid-scale test. We made the first test on February 8, 1989. We tested a lot of different conveyor belt constructions from manufacturers that were tested with the new belt test.

All different kinds of construction, such as rubber, PVC, composites, and there wasn't any charge. We want to see how well this test performs, and we want to give the belt manufacturers an opportunity to have tests run on the BELT test, and different compositions that they may come up with, and basically in a development type of thing for the manufacturers.

So in this whole program, we got a large database on different types of belt constructions that would pass, and that failed this new mid-scale test. And the data that we collected, and when the company went in, a specific belt company came in with their belt constructions, we gave them their test data.

And then what we did was we took all the test data from the different companies, and we provided that, and also incorporated it. It was not identified specifically to companies, but was identified as test data, and it was placed into the rule making record.

Now just to go over what the BELT apparatus involved, and you heard this several times before. It is a test chamber that is approximately six feet long, and it is a foot-and-a-half square, and it has got an exhaust transition section connected to it.

It uses a natural jet burner for the igniting source, and we have a steel rack that is used to hold the belt, with the test sample in the BELT test apparatus.

The belt sample, the test sample, is nine inches wide, by five feet long, and air flow through the tunnel is set at 200 feet per minute, whereas the 2G test is 300, and the BELT test is 200 feet per minute.

And the burner that we used for ignition is held on the sample for five minutes. Now what is the criteria in this test? Well, what does it take to pass the test? Well, we run three test trials, and if there is any belt sample left, it means that a portion of the belt sample left on the five foot sample is undamaged, and then the belt passes the test.

In any of the three tests if you have a complete burning of that five foot sample, it fails, and there has been some pictures of the belt test apparatus, and you have seen that, and this is the apparatus here with a hood in the front to capture combustion products that may escape from the tunnel.

This portion here was a scrubber that we had built to help control the smoke that was given off from the burning sample. Here is the igniting burner, and as Dr. Lazzara mentioned, this was an impinged jet burner.

This is what the test sample looks like, five feet long and nine inches wide. And this is the setup of the test sample in the tunnel. It is just a steel rack and basically the belt sample is placed on the rack and it is held down with cotter pins along the edge.

And this is what the flame from that impinged jet burner looks like to give you a rough idea. Now this is a start up of a test on a conveyor belt sample. You have ignition of the conveyor belt, and the belt is ignited, and the burner is removed, and the belt is burning.

The belt is propagating flame down the sample holder rack, and then what do you have left? Ashes in this particular case.

DR. BRUNE: Would this be a failed test?

MR. VERAKIS: Yes, it definitely would be a failed test.

DR. BRUNE: I just wanted to make sure I understand this.

MR. VERAKIS: This gives you an idea of a belt that passes the test. I mean, you can see that there is some burning, but not a whole lot of burning. Now we went through this test program with 21 belt companies.

We started the test program as I mentioned in February of 1989, and we ran this program until May of 1994. So for better than five years, we ran this program.

And there were 21 belt companies involved, and also a chemical company participated. They had a formulation that they provided to us that they wanted tested.

And then the data that we collected from over 700 individual samples, we ran more than 700 flammability tests. And what was the result? Well, we lumped it together. We had rubber and composites, and which was talked about yesterday by Phoenix about PVG belting, which is basically a rubber type cover and a polyvinyl core.

We had some of those types of belts that were brought to us from the belt companies that we tested, and then of course, different combinations of rubber, and there was mention yesterday about chloroprene rubber, which is a trademark really of neoprene, and blends of different types of rubber.

And then of course we had different PVC belting, and out of these tests, what we came up with or what we found was that 95 of the rubber and the composites passed the test, and on the PVC side, we had 38. So we had a total of all the work that we did that 133 had passed the test.

And what does the data look like? This is just an example, and one of the things that you consider, too, when you are doing this type of test work is what happens long term. Do the samples deteriorate on long term when you are doing testing.

Well, this is a chloroprene rubber belt. We ran the first three tests, and we get 17-1/2 inches damage. Here is the past/fail line of 60. Twenty months later, we run another sample of that belting and we get 15. Twenty-one months later, 18. Thirty-four months later, 18. This is almost three years.

DR. TIEN: I just want to make sure that I understand. Does number one correspond to number four, where the same belt was burnt? Is number one and number four the same belts?

MR. VERAKIS: Yes. This is the same belt over a long period of time.

DR. MUTMANSKY: Harry, what did you do with the belt in the interim period?

MR. VERAKIS: Just stored it in the lab.

DR. MUTMANSKY: You just stored it in the lab?

MR. VERAKIS: Yes.

DR. MUTMANSKY: I was just wondering. Okay.

MR. VERAKIS: So over almost a three year period, you have got this kind of data. Now as I mentioned earlier about the pass/fail belt test, if you were to run the test as an approval test, you wouldn't necessarily gather burn data.

It either goes the full way, or it doesn't go the full way, and you leave some belting left. You don't necessarily have to measure the belt length. But that gives you some kind of idea what is happening with the belting, and how well the test is performing, and how well the belt is performing.

When we talk about repeatability of tests, this was an issue. So what we did was we took a composite belt, or actually a PVG kind of belt, and we ran 30 tests on it.

We had a long length of that belt, and we set up a sampling plan on how to cut the samples out of that belt to run on the BELT test. And we ran 30 tests, and these are the kind of results that you got. I mean, here is the pass/fail line, and here is the average, about 28.

Rulemaking. When we had the meeting in 1989, we concurrently initiated rule making with the voluntary belt test program. As has been mentioned earlier, we ended up proposing a rule for testing and approval of flame resistant conveyor belting with the BELT test, and that proposal went into the Federal Register on Christmas Eve of 1992.

We had a comment period once the proposed rule was put in the Federal Register, and we had a comment period that lasted for approximately three months or so, to March 26, 1993.

And then we reopened the record at the end of March of 1995, and there was a request to have public hearings, and we held a public hearing on May 2, 1995, on the BELT test.

And then the record closed on June 5, 1995, and again it was reopened at the end of October of 1995. There were some issues that were brought up and so we reopened the record to gather more information, and the record was again closed on February 5, 1996.

Then another issue came up. There were several issues along the way, or more than several issues along the way with this rule making effort. We opened the record back up again in 1999, and one of the reasons there was because of the definition of what are small mines.

At the time, we had defined a small mine as being 20 miners or less. And then we had learned where the Small Business Administration had said, well, a small business is 500. So we had to do some more work. And then the record closed after that reopening on February 28, 2000.

Then in the semi-annual regulatory agenda that came out, on May 13, 2002, the belt test was in the final rule stage. We worked up the final rule for that approval with the BELT test, and then there was a notice in the Federal Register on July 15, 2002, that that proposed rule was withdrawn.

So we have done what since that time? We have not done any further rule making activity with the BELT test. The work essentially stopped there. And that's basically all that I have. Questions?

DR. MUTMANSKY: Why was the rule making stopped? You didn't say why.

MR. VERAKIS: The reasons were given in the withdrawal notice, and that we had AMS systems -- you know, better detection of fires, and conveyor systems were better, and improvements in the conveyor systems, and improvements in the idler makeup.

And, of course, there was a reduction in the belt fires, you know, from the time that we had started this in the mid-'80s. I mean, that was one of our concerns, is that there was an increase in belt fires, and we were getting a lot of belting that was burning up in these fires, and that was part of the thrust for the rule making at that time, and where there was a decrease in the number of fires.

DR. BRUNE: I assume that the rule making did recommend that the BELT test would have to be passed for a belt to be accepted or permitted for underground use; is that correct?

MR. VERAKIS: That the rule making would do what?

DR. BRUNE: That the rule making that was proposed would have required that the BELT test was passed in order for MSHA to permit that belt for underground use; is that correct?

MR. VERAKIS: Yes.

DR. BRUNE: Would you still today think that that is a rule that should be in place? I am putting you on the spot now.

MR. VERAKIS: Well, yes, but I think that is part of your committee's decision. I mean, it is obvious from the work that Dr. Lazzara and myself have done together on the conveyor belting, it is obvious what our situation is, what our position is.

DR. MUTMANSKY: But we want to know what you think.

MR. VERAKIS: What do I think?

DR. MUTMANSKY: Yes, sir.

MR. VERAKIS: Yesterday, Phoenix put up a graph, a table basically, and I had mentioned it earlier this morning, where you have tests from other countries there, up here, high, in terms of fire resistance, and you have the 2G test, which is basically at the bottom.

Generally the world thinks that we are leaders in this type of thing, and that we are going to be on the top and we are going to have the best. But based upon what was provided yesterday, that has not been shown.

And you continue to have fires, and that is the other problem. Yes, you can have monitoring systems, and you can have fire suppression systems, but as we know, these things can fail.

And your first line of defense is really your conveyor belt. I mean, it doesn't take coal, and it doesn't take wood to get the belt on fire. We had a belt fire, and in which quite a bit of belting burned up in it, and it was basically a bald entry. There wasn't any coal in it.

We have had mines that have been closed. Marianna, in 1988, the mine is sealed, and could not be recovered. So it is not only the effect on the miners and the mining industry, but it also affects the community. The Marianna mine fire affected that community.

And our goal was to come up with a better test, and if it is going to be an improvement. If you have failures in your monitoring system, and you have failures in your fire suppression system, whether it be a hope that you are not going to have a belt that is going to burn very much.

And, yes, you have these other tests. You have drum friction tests, and you have electrical resistance tests. But when we had these increases in the fires in the mid-'80s, and we knew what was going on in the rest of the world as far as development for fire resistant belting.

And we felt that the first thing that we needed to do was to keep the conveyor from propagating fire. If the conveyor belt propagates fire, then it can catch coal on fire, roof coal, and catch the wood supports on fire, and other things on fire.

And that was our main goal, was to limit that flame propagation, and if we can contain that flame propagation, we have a better chance of fighting the fire, too, and less chance of that fire getting out of control, and that was our main effort.

DR. BRUNE: Do you recall if any of the belt fires that you investigated after the BELT test was established, did you do any post-fire testing of the belt involved and find out if it would have passed the

BELT test?

MR. VERAKIS: No. Once the rule making stopped in 2002, we didn't do any further work really with the BELT.

DR. TIEN: Now there has been quite a few years since the BELT test, and also the rule making stopped a few years ago.

MR. VERAKIS: Yes.

DR. TIEN: Do you have any second thoughts as far as the standards for the BELT and if you are going to re-initiate it again, or a modification, or different things that you would do on the criteria?

MR. VERAKIS: Would we make changes to it? I don't think overall that we would make changes. There might be some minor changes. One of the things that we would want to keep is the comparability between the BELT test and the large scale test work that was done at Lake Lynn, because that gives you a foundation.

It gives you a scientific foundation for the test, and when you start tinkering with the test and making changes here and there, and others have done this -- the British have done this, and the Canadians have done this, where they have made modifications.

And it was mentioned yesterday about the propane gallery test, and the comparison between the BELT test, and some modifications that were made to the BELT test so that the BELT test would compare with the propane gallery test.

Well, our goal was to have the test compare with the Lake Lynn test, meaning if we would start tinkering now to change things on it that we could lose that comparison. We don't know exactly how that goes.

DR. TIEN: Yes, that makes sense. The last test you had done was for 700 samples or 700 tests. Only 133 passed?

MR. VERAKIS: Yes.

DR. TIEN: Would the improvement, I presume, over the years in the use, do you think the same numbers and the same ratio might hold this time?

MR. VERAKIS: No. I think it would be better. I mean, the 133, you have to remember that we did over 700 individual tests, but on the pass/fail basis, that is based upon three tests, because that is the criteria for the BELT.

So you have 133 times 3 or so, but I think today that the results would be different. There would be more belting that would pass the test, and the industry has a good idea of what the test amounts to and so do some of the other organizations.

MR. MUCHO: Harry, at that time weren't they playing with some formulations to pass the BELT test as well?

MR. VERAKIS: Yes, there were all different kind of formulations. There were belting samples that were brought into us, where we only ran one test. Belting companies would make up a formulation, and they would bring that formulation into us.

We would run one test and the first test failed, and there is no need to go any further. So it was really development, too, for the belting companies. You know, what kind of composition and changes, and so forth, that they needed to make in order to pass the test.

DR. CALIZAYA: You were talking about the Small Business Administration, and the definition of small mines. Could you further explain that?

MR. VERAKIS: The issue was that we had defined that the small mines were 20 persons or less, and then the issue came up, well, in your numbers, in figuring out your economic analysis, how many small companies you had and we were using a number of 20 or less.

And it came back that the Small Business

Administration uses 500 as a small company, and so we had to deal with that definition, and then you had to go back and redo your economic analysis, and what the impact is going to be.

MR. MUCHO: Harry, one question, and maybe this would have been better for at least the panel to participate in yesterday, but one of the issues that I see before this panel is -- well, to set the stage, it was just pointed out where the U.S. stands internationally on the low rank in terms of fire resistance testing for belts.

Obviously as you pointed out, the U.S. is not the leader, and we don't necessarily want to be the leader, but we wanted to at least have a system that ensures health and safety, and the elimination, if not the elimination of the minimalization of the hazard of belts catching fire.

So this then says, well, what sort of a testing procedure should we have, and you and Dr. Lazzara made the point about the BELT test, and the fire propagation.

The problem is that in the U.S., we don't have the experience with the broad range of tests that are used internationally, and the variations of them even in the drum friction test, for example, there are variations between different countries in that test, and how it is performed, and really the results also in terms of what they yield.

So things as we mentioned, the electrostatic testing, and you mentioned this morning the oxygen index test. It might be a good quality control test. So there is this pourporri of tests out there that are being done internationally, and without our experience in the U.S. for this panel to start looking at what might be the level that the United States might want to be at, it gets a little bit difficult in dealing with some of these other tests.

I think we have a good feel for the belt test, and what that is going to give us, but some of the other ones is a little more problematic for this panel based on the lack of U.S. experience with these tests, and the results that they yield, et cetera.

MR. VERAKIS: And there was work done by the British concerning their tests, versus the BELT test, and I take it that that was mentioned by Fenner-Dunlop yesterday on the work that was done there, and what kind of comparisons you get from the BELT test and the propane gallery test.

And, of course, the Europeans, as far as the standards for the European community, they were dealing with the same kind of issues, because as was mentioned by Fenner yesterday on what happened with the propane gallery test, and how you come up with a stalemate.

You know, this country test has their test, and this other country has their test, and they are comfortable with their tests, and they don't want to make changes and modifications.

And basically what I am getting from you is that you are in a similar situation that we were in during the mid-'80s. We have these number of different tests out there, and what are we going to do. How are we going to make improvements to the tests that we have. What are we going to choose.

And the way to look at this basically from the scientific view, you have to have a basis, because there are times when you have these tests, and you try and go back and relate them to some kind of scientific basis, and you don't have it.

You develop an apparatus, and you run a bunch of tests that say here it is, and we have drawn this line, and this is what you have to do to pass the test, and there it is.

And that has happened -- I mean, if you were to go back and we have had this difficulty with the drum friction test, and if you go back and look for the large scale test work, and the drum friction test is not a small scale test. It is on the mid-scale size.

You know, where does the data come from, and what has it done, and that is where you have some difficulty. What was the large scale work that was done to say, well, you need this kind of drum friction test. We had trouble dealing with that. We could not find that kind of data.

DR. WEEKS: Well, the scale of the test is one issue, but I think the more pertinent issue on the drum friction test is that is a very common source of the belt igniting, and if we are going to test belt ignitions, how do we do that. If belt ignitions are caused by belt frictions, how do we do that.

It seems to me that the drum friction test may have its weaknesses, but it pertinent to that particular problem, whether it is done on a small scale or a large scale, and that's why the drum friction test is pertinent.

MR. VERAKIS: Yes, that is supposedly the basis, but when you are going back and looking at the drum friction test, and then as Dr. Lazzara mentioned yesterday, if you have lagging on the drum, it is not like the drum friction test that is running on a steel drum. It is not the same.

So you have to deal with those kinds of things. I understand that it is --

DR. WEEKS: Well, friction is a common source of ignition, and how do we develop a test to simulate that in the laboratory so that we can put belts out there that don't ignite by friction, and that is the issue.

And if wrapping a belt around an idler won't do it, then what will. I mean, that is the problem right there, how do we prevent friction on the rotation of the belt, and there is a lot of ways to do that. Even belt maintenance is one.

MR. VERAKIS: Well, yes, to make sure that the belts are aligned so you don't get rubbing on the structure, because that has been a source, too.

DR. WEEKS: The question is how do we prevent that kind of event from happening, and the drum friction test is one, and there are other ways of doing it, but you at least want to try and address the problem.

It seems to me that the BELT test addresses the issue of flame propagation, correct?

MR. VERAKIS: Yes.

DR. WEEKS: And it is a very pertinent issue, but it is not the only issue. There are other issues.

MR. VERAKIS: Certainly, yes. It is not addressing the frictional ignition issue. It is addressing as you mentioned the flame propagation issue.

DR. MUTMANSKY: Harry, Tom used the word pourporri, and that sort of kind of brought some sort of negative feelings about in this sense. Wouldn't it be better if there was more standardization in testing?

You see if the German tests are different than ours, and the Australian tests are different than ours, and then if that is the case, then the belt manufacturers have a terrible problem. They have to meet all three.

And it would really be nice if we could somehow get together more internationally to come up with well established standard test procedures, and when we are looking for a new test procedure, we don't start from scratch, but we try to meld our test procedures with other countries so that the manufacturers at least have a more centralized target at which to aim their products. Has anything ever been done on an international basis along these lines?

MR. VERAKIS: Not quite in that fashion. I mean, we worked with the British when we were doing the Lake Lynn work and developing the belt tests. We worked with the British on the tests. We knew what kind of tests the British had.

The Canadians worked with us, CANMET, and they came and saw our apparatus, and actually they built the apparatus in Canada, and they also built the apparatus in England, the BELT apparatus.

And then the Australians, who we did some work with, we had contacts with them. But not as a unit of all of these different factions. And, yes, that is certainly -- I think that is an admirable goal, is to have universal tests, because certainly the belt manufacturers have to deal with the different country's tests.

But it is a difficult thing as you saw yesterday with the Europeans, and trying to standardize this. But it is certainly something that should be done. But really from my personal opinion, is that you have to have a scientific basis for it, and it has to be as realistic as you can possibly have it.

So you naturally work on a large scale, and you go from there. But I would suggest that you look at the work that the British have done in comparison to the two tests, and that will give you some idea how the BELT test compares with their tests, and the same thing with the Canadians and the work that they have done, and the work that the Australians have done, and we can provide you with that information in papers.

DR. WEEKS: I just have one other question, and it is very broad in scope and I guess the '89 to -- well, the rule making was started in '89, and you said there were a number of issues along the way, and you mentioned the Small Business Administration problem. What were some of the other issues?

MR. VERAKIS: There were issues like the repeatability of the test. There were issues about -- and what was talked about yesterday, combustion toxicity.

DR. WEEKS: Combustion toxicity in what sense?

MR. VERAKIS: How do fire resistant materials compare with non-fire resistant materials as far as combustion and toxicity. So you have a more fire resistant belt than your current standard, and does it create a more toxic problem for you.

DR. WEEKS: How did you deal with the issue of that and what was your approach to that?

MR. VERAKIS: Well, one of the things is that we had a lot of tests with the BELT test, and showed testing over a long period of time, and when you get into flammability testing, there is always that difficulty about repeatability because you are dealing with a dynamic phenomena.

I mean, you have operator dependency, and you have got materials that may not be completely uniform. As I mentioned earlier, we tried to come up with a standard for 2G, and that was a difficult thing to do.

DR. WEEKS: Well, for example -- I mean, with the variability from the tests, I mean, one would conclude that you would just take a lot of tests and an increase in number. I mean, for example, if a belt test had gone into effect, would you require something like 20 tests and you had to pass all 20 in order to meet the requirements?

MR. VERAKIS: No, we would have stuck with the three.

DR. WEEKS: Three?

MR. VERAKIS: Yes.

DR. WEEKS: And they would have had to pass all three?

MR. VERAKIS: Yes, they would have had to pass all three, but if that test was instituted and that was going to be our approval test, then what we would have done is as things went down the road, we would have taken samples from the industry and checked them out and see how well things are going.

DR. WEEKS: What was your solution to the toxicity problem?

MR. VERAKIS: The toxicity problem is a complicated issue. One of the things that we did is that we looked at the work that the National Bureau of Standards had done, and the National Bureau of Standards had done work comparing non-fire resistant materials to fire resistant materials, and what were their findings.

And from that work, their findings weren't that fire resistant materials were more harmful than the non-fire resistant materials. There wasn't anything that stood out that said that fire resistant materials are bad as far as combustion toxicity goes.

You are going to have less material burning, and you have less of the material into the atmosphere. So from their point of view, that wasn't the problem, and if you go back and you look at other things, and you look at the -- let's take something like children's sleepwear, you know. We have got fire resistant children's sleepwear.

DR. WEEKS: We don't find much of that in mines.

MR. VERAKIS: No, you don't, but there are other materials where you use fire retardants that are similar that you use in conveyor belting.

DR. WEEKS: Well, the issue here for us is if we come along and say we should reinstitute the BELT test, I just want to know what it is that we are suggesting. For example, if you had said, yes, we have to have 20 tests in order to make it valid, that makes it problematic.

And the toxicity issue from what I hear you saying is not really a problem. I mean, there might be different materials that come off of flame resistant materials, but not from belts.

MR. VERAKIS: Right.

DR. WEEKS: So it does appear to be a problem.

MR. VERAKIS: I don't consider it to be a major problem, no.

DR. WEEKS: Were there other issues in that 13 year period that we should know about?

MR. VERAKIS: I think one of the things --

and I think we provided to you the public hearing record that we had in 1995, and that gives you a pretty good idea of what some of the issues were.

And it is also that you get into the economics, and what is it going to cost. Questions were asked yesterday about what is it going to cost, and what is this new belting going to cost, and at the time that we were working on the economic analysis for the final rule work, and the numbers that we had, the information that we had was that the range was somewhere on the order of about 5 to 30 percent, 30 to 35 percent.

And you hear different numbers, like well, it is going to be 50 percent, and it is going to be 40. But there were some companies that told us, well, we can make a belt that passes that test, and there is not going to be any cost differential. So there was a range.

MS. ZEILER: Any more questions? If not, thanks a lot, Harry, and I think we can take a 15 minute break at this point.

(Whereupon, a short recess was taken.)

MS. ZEILER: All right. I would like to welcome Terry Bentley, who is here from MSHA's Coal Mine Safety and Health to give a presentation on the historical data on belt fires. Terry.

MR. BENTLEY: Good morning. Jan Mutmansky just a moment ago came over and introduced himself, and I introduced myself yesterday to Jim Weeks. So let me introduce myself to the rest of the panel.

My name is Terry Bentley, and I am standing in for Mike Kalich. Mike works for me. He is currently acting as the Chief of Safety, and I am the Chief of Safety for MSHA Coal Mine Safety and Health, and have been for nearly four years, and currently I am filling another role in headquarters. I am the special assistant acting to the administrator right now.

But Mike was detained. We have him on a mine rescue rule right now, and we are trying to get that thing perfected, and out the door hopefully within the week.

So without further delay, I would like to address a little historical perspective about reducing belt fires in underground coal mines. One program note for you folks, barring any unforeseen difficulties, today at two o'clock the Aracoma report will be released and posted on our website, and that is current as of about 30 minutes ago, unless something changes.

So if that is the case, that we do in fact release it, copies will be distributed to you folks before the meeting is over. Is that correct, Linda?

MS. ZEILER: That's right.

MR. BENTLEY: Talking about belt fires in underground coal mines, one of the things of course that I want to talk about is the maintenance aspects, but looking back historically, many of the belt fires can be attributed to maintenance type issues, and in particular attributed to frictional heating, belt slippage, and things like that, and welding in some instances, and you will see that in the course of the presentation.

Belt fires. You probably are aware that there has been a change in the reporting requirements for belt fires. Well, for that matter, for fires in general.

Previously there was a requirement in the regulations that a fire that was not extinguished within 30 minutes, and as most of you may be aware, because of the final Mine Evacuation Rule, which was finalized on December 8 of last year, it is now a 10 minute reporting requirement.

And a belt fire is reportable to MSHA, of course, if it causes a death or severe injury, and takes now 10 minutes or more to extinguish after discovery, and of course in accordance with the rules, the fire must be reported within 15 minutes.

And to put that in perspective, because the data that we have is actually based on the 30 minute previous rule reporting requirement, because this is a brand new rule, of course.

Some data that we had in 2003. For example, selected year, three reportable fires, and 37 non-reportable fires, and that of course is in accordance with the 30 minute rule requirement.

A 25 year history of reportable belt fires starting in 1980 through 2005, and you can see the breakout. You may also notice -- and I think Harry had made a reference to -- Harry Verakis had made a reference to the 1995 period, which would be right in this area here, and that belt fires had lessened in that period of time.

So this does correlate pretty much with what Harry said. As you can see in later years, there have been additional fires that were reportable, somewhere in the 4 to 5 range for a couple of years there.

In this chart, you can see belt fires reported per thousand mines on the left here, and on the right, of course, we have the number of active underground mines. You do see a decrease under the years from 1980 through 2005.

And since 2005, there has been an increase. Not a dramatic increase with the production of coal, but the underground mines are probably more in about the 600 underground mines that are active and producing, and we certainly have other mines that are non-producing that we inspect in the presence of mine personnel.

But give or take, it is in the 600 mine range, the number 600. You can also see the rate of entry of belt fires per thousand active mines, and you can see the number of belt entry fires. And it is kind of interesting.

There have not been that many reportable again under the 30 minute rule, but as you can see, it fluctuates, but not a significant number over any year that would really in my view give you much of a dataset in terms of a trend without a greater population of mines.

So from 1980 until 2005, there were reportable fires, 63, and I think it is significant to point out that in that period of time there were no fatalities in underground coal mines attributed to belt fires.

And also there were no reportable lost time injuries. Now we do know that there were some mine fires where folks did experience some smoke inhalation, but remember Part 50 requirements for reporting, and just to touch on that a bit, someone could be administered first-aid, and that is not necessarily a reportable Part 50 accident if there is no medical treatment. Also, if they return to work the next day.

So we have no record of reportable lost time to injuries in that 25 year period, nor any fatalities between 1980 and 2005. And this information you may notice down at the bottom was obtained -- and as well as some of the other information that has been pulled here from the MSHA Atmospheric Monitoring Survey, which was done in 2003.

So historically belt entry fires, there have been more damage to belt structures, the mine, and infrastructure, and so forth, than there have been of course for fatalities.

Obviously, we do know that the Aracoma report will point to two fatalities in 2006, but historically there have been much greater damage to the mine infrastructure, belt structure, equipment, and so forth.

You can also see the Aracoma picture in the right-hand screen shot there, which does show some of the belt structure that was damaged. Cause of the belt fire, which is a non-injury event, does result of course in significant cost. I don't have a dollar figure for that. I am not an economist.

But obviously there is a substantial loss of production days in many instances, and rehabilitation costs can be very extensive, not only to replacing electrical components, and belt structure, and infrastructure, but also to the mine roof, which may need extensive rehabilitation.

Mine rescue expenses, and extended work hour for mine management. A major belt fire event is an extremely costly event, even without any injuries. Increasing trends. Obviously coal prices have risen, and production has risen accordingly because there is a tremendous demand.

And you can see charts again from 1980 through 2005 showing an increase in coal production, and average cost of metallurgical coal, and coal plants, and you see the various coal fields, the Central Appalachian coal fields, and North Appalachia, Illinois Basin, and the Powder River Basin, and the Uneta Basin.

And as you can see all the prices have risen, and for a period of time, they did peak, and they have come down a little. Not dramatically. There has been a great increase in push for production.

For example, a long wall belt could experience downtime, and this is 2002 figures, of at least $30,000 per hour, and you could certainly extrapolate that and presume that that cost is much greater now in 2007.

Obviously, larger mines do have longer belt lines and larger belts certainly associated with longwalls and increased production in general, and there has also been a trend for fewer belt attendants, and that would probably be attributed to increased labor costs.

For example, 10 drives and 5-1/2 miles of belt generally would be something typical of three attendants per production shift. I can recall previously when I was an inspector that most mines had an attendant at every drive location, and was responsible in many instances for only one section of belt.

So obviously labor, and over time, the cost of labor has risen, and that has impacted on the number of belt attendants. And we talked a little bit about preventing belt fires, which involves early detection, and certainly maintenance in extinguishing belt fires.

I can't say enough about proper maintenance and examinations. I think that maintenance is very important. Examinations are a critical part of belt fire prevention. Without it, I think it is a prescription for problems.

Fifty-six percent is a portion of accident reports that have identified inadequate maintenance as a contributing factor for reportable belt fires. Again, this comes from -- no, I'm sorry, this does not come from our AMS survey. This comes from MSHA accident investigation reports for the reported fires between 1980 and 2005.

An example of a typical roller, which caused the fires and contributed to heat and friction. This is another one, hot rollers and bearings from our accident report data. Ten percent of reportable accidents, and 63 percent of non-reportables.

Now the non-reportables do come from our AMS survey, and is attributed to hot rollers and bearings, obviously a significant maintenance issue. This is a typical shot showing devastation and damages as a result of a fire. Obviously you can see some smoldering ambers still present there.

Another shot showing fire damage as the result of a belt fire. Belt friction. According to our data, friction along belts, 18 percent of reportable fires were attributed to belt friction, and six percent of non-reportable fires were attributed to belt friction.

Friction at drives. Again, as you will recall, I combine these together, as it is a substantial amount. Friction at drives, 18 percent reportable; and 8 percent not reportable.

And I alluded to welding and cutting earlier, 10 percent reportable; belt fires, 8 percent not reportable. Again, this is from the period of 1980 through 2005, a 25 year history.

So reported fire ignition sources, 18 percent of belt drives, friction; 18 percent friction on long belts; 16 percent attributed to electrical issues, including diesel and hydraulic grouped together.

And eight percent attributed to cutting and welding, and 10 percent attributed to hot rollers and bearings, and 30 percent, which was a variation, all lumped together indeterminable. So as you can see, a lot of these fire ignition sources are clearly maintenance related and probably in many, many instances examination related.

Non-reportable fire ignition sources; welding and cutting, 8 percent; 63 percent, hot rollers and bearings; 8 percent, friction at drives; and 6 percent, friction along belts, and 15 percent attributed to electrical related issues; hydraulic, diesel, and so forth.

And remember that these would fall within the 30 minute non-reportable period under the previous regulation, and this comes out of our AMS survey. Obviously, atmospheric monitoring systems can play a large part in detection of belt fires well before it becomes a truly fire situation because of CO detection.

However, proper installation and maintenance is absolutely critical, and of course the proper operation, and I would also add to that when you talk about operation, you need to have very well qualified AMS system operators on-hand, and they need to be competent, and well trained, and knowledgeable, and have the ability to make decisions and respond if they have certainly alarm levels, and even at the alert stage as well.

In 2000 and 2003, there was 32 non-reportable fires, and 37 were detected by using the CO monitoring systems in an 18 month period.That is probably pretty indicative of the value of a CO monitoring an AMS system if it is properly maintained and properly used.

And of course the last resort, which we hope we don't get to, is extinguishing the belt fires, and I have already alluded to the cost, notwithstanding if there are injuries or fatalities. Significant costs.

So in conclusion, we could say, yes, in the near term belt fires have increased in frequency and severity between 2002 and 2006, and I would again point back to the value of adequate maintenance, which significantly can and does prevent belt fires, and certainly a factor in over half the fires from our data.

And once again I would point to early detection, well maintained fire suppression systems, water pressures, and so forth, and fire fighting equipment provided as the last line of defense, and that concludes my portion of the presentation. Does anyone have questions at this point?

DR. WEEKS: Initially, I have a question about fire prevention. You talked about fire prevention, and you didn't say about the composition of the belts, and you mentioned about the maintenance of the belts, but you didn't say anything about the belt composition.

MS. ZEILER: Jim, could you move the mike closer to you. We are having a difficult time hearing you.

MR. BENTLEY: I think that is an important aspect, and in my view, we certainly want to try to prevent it through maintenance, but certainly flame retardant belt properties would be highly advantageous. There is no question about that. It was not a part of this presentation.

DR. WEEKS: I know.

MR. MUCHO: Terry, I missed a part. The non-reportable data, where does that come from?

MR. BENTLEY: It comes from our AMS survey that was done by some folks in technical support from records on the AMS systems of fires that did not rise to the level that needed to be reported within 30 minutes.

MR. MUCHO: My question is how did MSHA become aware of these incidents?

MR. BENTLEY: I didn't do the survey, but I am pretty sure that it was given voluntarily by a certain population of mining companies. I don't even know if Harry knows the answer to that, but I do not.

MR. VERAKIS: So how do we get the non-reportables for fires? As Terry has mentioned, there are surveys carried out trying to gather this information from mine operators, and looking at their records, and taking that information, and see what is happening out there.

MR. MUCHO: So is that from the AMS systems where you had an alarm level, but not 30 minutes duration? Is that where it is coming from?

MR. BENTLEY: Yes.

MR. MUCHO: Because they go to the hot bearings, and so on, and there are many instances of hot rollers, for example, and this 63 percent number comes from something that induced an alarm level.

MR. BENTLEY: Inducing an alarm and progressed to a fire at some point.

DR. WEEKS: If I could just follow up on that. Was that survey done only of those mines that had AMS systems in place?

MR. BENTLEY: I don't think it was done in all mines that had AMS systems, but just a selected number, and again coal mine safety heath didn't do it. Tech support did it. So I would have to defer to someone in tech support on that point. Bill Francart assembled a lot of this data, and Bill is not with us today.

MR. VERAKIS: We can get that answer from --

MR. MUCHO: We have seen the data, and it was the AMS system mines, and so the data came from all AMS system mines.

MR. BENTLEY: Right, and whether it was everyone or not, I'm not sure. But it may have very well been all of them.

MR. MUCHO: It was and the data has been updated from 2003 to 2006, and that information has been provided to the panel.

DR. WEEKS: But as far as the reportable fires, were those that are in the Part 50 dataset; is that correct?

MR. BENTLEY: That's correct, that were not extinguished within 30 minutes.

DR. WEEKS: And so that would include in the common denominator all mines, and those in the Part 50 dataset.

MR. BENTLEY: I think you would be correct, yes.

DR. WEEKS: But the nonreportables only focused on the data of those mines that had AMS, and so it is a much smaller denominator.

MR. BENTLEY: Because there would be no other record of the population of AMS systems.

DR. WEEKS: So the implication is that the number of non-reportable fires is larger?

MR. BENTLEY: I think you could make that presumption and be correct, yes. The number we wouldn't know.

DR. TIEN: Terry, you mentioned that you were an inspector before?

MR. BENTLEY: I was an inspector in Hazard, Kentucky, and I came to MSHA in 1982, and I was an inspector there for about 5-1/2 years or so.

DR. TIEN: I am just curious. As you are doing routine inspections do you look at the AMS as part of your record?

MR. BENTLEY: Yes, as part of the regular health and safety inspection. I will have to tell you that when I was inspecting there were no AMS systems. I worked in District Seven, which is Hazard, Kentucky, and headquartered out of the Barboursville District Office, and then in 1988, I went up to the Anthracite Region for about 8 years, and in 1996, I went out to our Illinois Basin.

I was a field office supervisor in

Pennsylvania, as well as a health supervisor, and then in 1996, I was a special investigations supervisor for criminal issues, civil issues, and discrimination issues, as well as accident investigations.

Plus, I was a staff assistant to the district manager at that time. I came to MSHA headquarters in the fall of 2000 in the division of safety as the deputy chief of safety, and not quite four years ago, I became the chief of safety. So I have been in MSHA since 1982, and it seems like it was only a few days ago.

DR. TIEN: Since the nonreportable came from AMS records, I assume those numbers would be pretty accurate.

MR. BENTLEY: I believe it is, and I would have to defer to Bill Francart on that. I guess we can get that information. Bill provided us the data for this presentation, and Bill is involved in an accident investigation review right now.

Our folks -- we are spread pretty thin at this point. There are only so many of us, and we are wearing a lot of hats in the agency right now.

DR. WEEKS: We have sort of a practical problem for this panel, and I share your concern about mine maintenance, and we could write in our report that operators to maintain their mines. I mean, it is one of those statements that -- well, is there some need for a ruling on maintenance, or is it a question or enforcement, or is it a question of common sense, or morality? I mean, what kind of issue is this?

MR. BENTLEY: You are asking me for my opinion?

DR. WEEKS: Yes.

MR. BENTLEY: It is probably a combination of all those probably that you touched on. Morality or ethics. That may be a bit out of bounds.

DR. WEEKS: Well, I am not just asking you.

MR. BENTLEY: I know you are, and all those considerations, and I think the point that you are trying to make if I understand it is that a responsible mining company would want to consider maintenance as a very important part of a functioning operation, because ultimately it translates into production.

I think maintenance in general in many instances is focused very much of course on the production aspects, but when you talk about the operation of a belt system, a belt conveyor system, that in and of itself is extremely production related.

So I think in general that I would agree with that, that it would be a range of factors. But I would recommend to any mining company that maintenance and prevention would be a key component of their operational planning. And I think that for many, many companies that it is, of course.

DR. GALIZAYA: Just to follow up on the same issue about maintenance. I would like to know a little bit more about procedures, and focusing on this maintenance problem, and the actual procedures.

MR. BENTLEY: We have regulations that our inspectors use during the course of an inspection where they are not targeting maintenance, but that is a result of enforcement, is better maintenance.

But I think that probably you are leading to something like a specific policy or even a regulation which would put more focus or impetus on maintenance.Is that what you are saying?

DR. GALIZAYA: Yes, and training as a part of that.

MR. BENTLEY: I think that training absolutely would be a part of that. I think that the proper training of personnel in the upper echelons of mine management, and all the way through the production folks, and maintenance folks, and down to the rank and file miners, translating into the value of preventive maintenance would be very important, and would be useful.

DR. MUTMANSKY: On those 56 percent of belt fires due to maintenance issues, would you be able to identify what types of mining companies are most normally associated with belt fires that are due to maintenance issues?

Would they be big companies, small companies? Is there any -- have you identified any characteristics of those kinds of fires?

MR. BENTLEY: I don't think that was done, and this would purely be speculation on my part. But over a 25 year period, you could probably surmise that earlier in the stage, in the period, would probably be larger companies that have employed AMS systems.

AMS systems are more widely utilized now, of course, and in smaller production mines. But still I would say that it would be a medium to large size company, as opposed to smaller companies that generally don't use AMS systems, and go back to detection for the point type sensor systems, heat sensors.

MR. MUCHO: I don't know if that is as true today, Terry. I think it started out that way and it certain did in belt air lines, especially along the long wall mines.

But looking at the most current data that we have, certainly the mines that I am familiar with, I was very surprised to see the number of small mines in that.

And certainly the State of Pennsylvania right now, the mines that are running AMS systems, and using belt air especially, are non-long wall mines. So it is a bit of a surprise and a bit of a change has happened more recently, I think.

MR. BENTLEY: I think in the latter period though that is absolutely true, as opposed to the early part of, let's say, the 25 year period.

MR. MUCHO: The other thing that I want to go back to is this 56 percent number on maintenance that Jan was just talking about, and Jan used the words fires due to maintenance issues.

Is that number related to maintenance wa the cause, inadequate maintenance, or inadequate maintenance was a factor?

MR. BENTLEY: Could you repeat that? I am not sure that I understand the question since they are both maintenance related.

MR. MUCHO: If you could go to that slide. It is a contributing factor.

MR. BENTLEY: Yes.

MR. MUCHO: Which can be a very different animal, and certainly in terms of magnitude as far as being a key factor.

MR. BENTLEY: I would agree with that.

DR. WEEKS: The issue there is did you control maintenance and not necessarily addressing the root cause of belt fires.

MR. MUCHO: Well, the implication is that I have a problem that causes a fire in a belt, and as I walk along the belt, I find some other maintenance issues that could have been there, and may have contributed somewhat, and helped with the problem, or may have been a non-factor.

So my root cause was maybe a hot roller or bad bearing in the back, or something like that, and that was my root cause, but in the meantime, there was a misalignment or whatever. But they could be talking about other kinds of maintenance issues, a whole host of things.

MR. BENTLEY: Without the data, I am not sure. But the only thing I can say is that it would be a maintenance related issue, and no question of an examination issue, too, and probably most of these.

DR. TIEN: Well, Tim, I had the same

question, and let's reverse the question. What are the non-maintenance contributing to the fires, some of the cases that you might think of.

MR. BENTLEY: That is a good question. I am not sure that I know the answer. Non-maintenance contributing fires.

DR. TIEN: Is it because of hot rollers, or because of a lack of maintenance or improper maintenance that caused the fire or is contributing?

MR. BENTLEY: Well, welding would be maintenance and repair, and we have grouped it in with those.

MR. MUCHO: You know, the electrical ones.

DR. BRUNE: A belt frame falls down because of roof instabilities, and that is not necessarily something that you can foresee and do something before it happens.

MR. BENTLEY: No, unless -- and it is not really a maintenance issue. In a broader sense it is, but if the mine roof was not properly attended, or support, that caused it. But I don't think that is the maintenance that we are referring to here. Overall mine maintenance, but not maintenance in the sense of a well functioning belt system, belt conveyor system.

MS. ZEILER: If there are no more questions, thanks, Terry.

MR. BENTLEY: Okay. Thanks, folks, and thanks again to the panel.

MS. ZEILER: I would just make a note that at this point all the presentations by MSHA and NIOSH, and the belt manufacturers on the issue of belt flammability have been presented to the panel.

So at this point, if you would like to start any kind of discussion, we could do that. It is up to the Chair on how you would like to proceed for the balance of the morning.

DR. MUTMANSKY: At this point in time, I think it is important to get the panel reaction. I would like to mention that last night at dinner, we were discussing how we would proceed after all the hearings have been held, and how we would form subcommittees to address these various issues.

I would propose, however, that we may wish to use tomorrow morning's time to discuss this further, unless the panel is intent upon discussing them at this particular time.

My reasoning in proposing this is that I would like to hear more about the 1992 committee's report and how some of those issues played out, and I would think maybe it would be important for us to hear what Dr. Ramani has to say about the 1992 report before we begin serious discussion of belt flammability issues.

But I would like to hear from the panel. The panel may not agree with me, and that is just my thinking on this.

DR. BRUNE: I don't know if this is the appropriate time, but I had one issue that was addressed in individual discussions, but I would like to address it for the record.

I had some discussions with some of the representatives from the manufacturers regarding deterioration of belt quality, especially with respect to flammability over time.

And I don't know if there is an opportunity to ask the manufacturers representatives to address this at this time, or do we have any other opportunity?

MS. ZEILER: If they are comfortable answering the question, they can answer it now, or we could set something up for immediately after lunch if you want to.

DR. BRUNE: Well, Mr. Kusel, did you want to comment on that, and I am especially referring to that discussion that you had with me on the Rambo mine.

MR. KUSEL: Yes. There was one issue where in Australia there was a mine called Rumble, and that is maybe 15 years ago, where a belt fire occurred, and the belt was burned, and there was an issue between the manufacturer and the authorities, the Australian authorities, about the fire resistance of the belt.

And so as far as I know the manufacturer said that the belt was approved, and it was okay when it was supplied, and when it was tested. But after a couple of years when the belt fire occurred, the belt properties had changed.

So it was finally not solved, and I think the main reason for Australia to come to more severe requirements.

DR. BRUNE: Would those requirements include testing at a later time, or let's say a validity date until this belt can be used, almost like an expiration date? Is that what the Australians do?

MR. KUSEL: I think the main point was that the belt supplied was based on SBR rubber, and as we heard yesterday, you have to add fire retardants to get the flame resistant properties of the belt, which is not the case in the neoprene.

So the Australian standards became more

stringent in this regard so that as of the new regulations, only neoprene belts, which could not deteriorate, would be approved and allowed.

DR. BRUNE: Thank you.

DR. WEEKS: I have a question about that. You mentioned belts deteriorating over a period of time. How much time are we talking about?

MR. KUSEL: Maybe 3 to 5 years. I am not sure.

DR. WEEKS: Well, short in the life span of the belt then.

MR. NORMANTON: Let me clarify that point.

MS. ZEILER: Could you wait one second so we can give you the wireless microphone so everyone is on the record. Thanks.

(Pause.)

MR. NORMANTON: My understanding of that was different with an SBR belt, and that the fire was of sufficient magnitude to cause propagation, and so I don't think it was an issue of material, per se, but that the composition of it in a worn condition was different than as to when it was new. And under most regulations worldwide, we are required to supply belts that meet the regulation when new.

And often there are simulation tests to

predict the behavior when warn, as per some of the U.K. tests, and Australian tests, where the curlers are buffed away down to the fabric or down to the steel cords.

And as manufacturers, those of us who would test the products after being in the field for several years, and we have a very thorough understanding if there is going to be any changes in the performance of fire resistance.

And I can't speak for other manufacturers, but certainly ourselves, we don't feel that is a big issue, or an issue at all.

In fact, the propagation test also requires a strip of rubber being removed down to the fabric also, and a hole punched through the belt to simulate kind of a worn condition.

So that is a requirement that is found around the world, but isn't currently a requirement in the MSHA 30 CFR 18.65. It is kind of a subjective area though as to what is a worn product.

DR. WEEKS: When you say that requirement is found around the globe, can you say some more about that and how does that show up in belts?

MR. NORMANTON: Some of the standards require worn simulation testing in either the small scale test or the large scale test.

DR. WEEKS: In minimal approval?

MR. NORMANTON: Yes, and also the ongoing quality control.

DR. WEEKS: And it has to pass that test in order to be approved?

MR. NORMANTON: Yes.

DR. WEEKS: Is there any time implications involved?

MR. NORMANTON: No.

DR. WEEKS: Like a belt does not expire or there is --

MR. NORMANTON: There is no expiration. I mean, belt life can be one month, three years, 15 years, depending on the length of the products, and the quality of the product also.

DR. MUTMANSKY: It just sort of came into my mind that we have one more person who is likely to be speaking on belt issues, and that person is Tom McNider, who I believe will be speaking to us this afternoon.

So that is another reason why the panel should perhaps begin to discuss these things tomorrow morning. Tom, you will be speaking on some of these issues this afternoon I take it?

MR. MCNIDER: Yes.

DR. MUTMANSKY: Okay. So at this point is there any other speakers who would like to discuss these belt flammability issues, and in particular the manufacturers who are here this morning, and may not be here tomorrow morning? Are there any other comments that you would like to make at this point in time?

(No response.)

MS. ZEILER: If not right now, and they will be here this afternoon, and they will still have an opportunity in the public input hour. So we don't need to close the door just yet.

DR. MUTMANSKY: Thank you, Linda.

MS. ZEILER: If there is no further discussion, then we can take a break for lunch and reconvene at 1:00.

(Whereupon, at 11:40 a.m., a luncheon recess was taken.)

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A F T E R N O O N   S E S S I O N

(1:06 p.m.)

MS. ZEILER: Okay. I would like to mention once again that if anyone wishes to make comments in the public input hour at the end this afternoon, you need to sign up on the sign-up sheet by the door.

And this afternoon, we have Robert Krog leading off from NIOSH to further discuss a few more issues that NIOSH would like to have the panel consider in terms of research. Robert. Thank you.

MR. KROG: Hello. My name is Robert Krog, and I work for NIOSH at the Pittsburgh Research Lab, and what I am going to be presenting is just a general overview of the ventilation with belt air on longwalls in the United States.

We can do this one of two ways. Anytime you guys want to interrupt with a question, please go right ahead. It won't bother me at all. What I am going to be talking about in general is the general ventilation practice, and of course calculating the concentrations of various dust sources or methane at locations.

And the previous use of belt air and the current uses of belt air in the United States, with regard to gate road development, and also during longwall panel extraction, and I will summarize the results.

In the United States, there are approximately 45 longwalls operating in coal. A lot of totals end up using the two mines in Wyoming mining and Trona, which should not be counted.

There are currently five entries, five mines that use four entry gate road development system, and 39 of them that use a three entry system, and five mines in Utah that use a two entry gate road system.

General guidelines taken from various sources about air flow velocities that should be expected in intakes and returns. For intakes and returns, 600 to a thousand feet, dust starts becoming an issue at the upper values.

The track entry, four to six hundred can be higher, and if the belt is on intake, about a hundred to 250, and when the belt is up by neutral, 50 up to 200 feet per minute out by.

MR. MUCHO: If I could interrupt you, Robert.

MR. KROG: Please go ahead.

MR. MUCHO: Air velocity guidelines, where are these guidelines coming from?

MR. KROG: Well, these are not strict

guidelines. They are not MSHA requirements. It has a lot to do with economical based on how much -- you know, at one point -- well, let me start back up again.

The values have a lot to do with dust, and once you get above 800 feet or so, you can start picking up dust. The other part becomes what I refer to as economical step functions to the right, and that is putting more and more air through a single entry at some point gets prohibitively expensive.

And then you would go to two and three, and the same way you develop your mains. The number of mains are developed by how much air you require, and that determines how many mains you require.

When you are talking about gate road development, you are trying to minimize the amount of gate road entries you can have to get to your values. These aren't strict numbers. The value -- and I believe it was in 1984 in Mutmansky, was 1,150 feet per minute maximum for a return.

That does not mean that you can apply that to every single mine. These are just general type guidelines. Does that answer your question, or --

MR. MUCHO: And the economics ties in where?

MR. KROG: Oh, the economics, and what I

refer to as an economic step function, a lot of times people refer to an entry, and they just keep putting more and more air into it, and they show that the costs -- as you know, if you put twice as much air through an entry, you get four times the head loss, and it costs you eight times the requirement power.

But at some point, when I refer to economics steps in, and where it becomes a step function, is where it becomes beneficial to have two entries in parallel instead of just putting all the air through one entry.

So that is where it is an economic step function. At some point, you keep moving more air, but the economics is where you have to go to multiple entries to supply your air or return your air, and that is when you get a large -- I refer to it as an economic step function on a per cost basis, including capital.

DR. GALIZAYA: I have another question on the same issue. What is it for the longwall face?

MR. KROG: For the longwall face, it is about 600 feet per minute across the longwall face.

DR. GALIZAYA: Is that a guideline?

MR. KROG: No, I am not giving you a guideline of what is required. I mean, that is based on or is site specific. I am not giving you a guideline to say what air is required on a longwall face.

That is a combination of your methane, and if you drained it, and what is your coal extraction rate, and the height of your entry. For example, the amount of air that gets moved in a Pokey Three mine, compared to a Pittsburgh mine, that velocity isn't -- -- you can't just generally apply it to different coal beds.

That's a function of an in situ mine. That's why I didn't give a value of what is required for a longwall. Does that answer your question?

DR. GALIZAYA: Yes.

MR. MUCHO: Let me just jump in.

MR. KROG: Go right ahead.

MR. MUCHO: Some of these numbers, like belt intake, you have a hundred to 250 feet per minute. That is with the belt on intake air, and I am still having big problems with the word guidelines, I guess, and where that is coming from.

MR. KROG: Let me say that these are not NIOSH guidelines. I guess that is the key word. Suggested is the better word, or what some mines are doing in practice.

These are not guidelines that are rigid requirements. These aren't legislative values. These are just typically what mines that I have talked to are dealing with, and how they are moving their air.

Like on the outby neutral, they are trying to use the minimum requirement, which is 50 feet per minute, but they require a little bit more than that to get rid of the dust and the methane, and so they put in a hundred feet per minute or 150 feet per minute. These are more like ranges.

MR. MUCHO: So this would then be ranges of what in general --

MR. KROG: Typical ranges. I think the term would be typical air velocity ranges I think would be a better description than guidelines.

MR. MUCHO: All right.

MR. KROG: The use of belt air, and providing a secondary source of intake air to the working face. A lot of previous work on using belt air dealt with dust in like '96 and so, and dealt with the amount of dust concentration that would be picked up from a belt, compared to the amount of dust that you get on the intake, and you get this simplified equation, which is your concentration at the face, as a combination of the concentration of the intake, times the quantity, plus the concentration of the belt air, times its quantity, divided by the intake and the belt combined.

It is just a general type question. So if you have a high amount of dust in your belt, it can get diluted by the amount on the intake, on the intake site, as long as the intake dust quantity is lower.

DR. WEEKS: It is a weighted average?

MR. KROG: It is a weighted average. It is a simplified weighted average equation. That is typically what was used for a calculation on the creating of dust, assuming two entry points. The next two slides are going to be based off previous work to deal with dust. NIOSH went to four mines and measured -- do we have a laser pointer?

(Pause.)

MR. KROG: What we have here are four mines that had on their belts an intake that recorded the dust, and it calculated value. The blue values right there for all four are what the calculated or that were measured dust levels in the belts.

I'm sorry, to white is the belts, and the blue is the intake, and the yellow is the calculated, using the previous equation on the previous slide, to calculate what the expected dust load would be at the face.

As you see the recorded dust loads were significantly higher and the reason for this is that the sample locations for the intake and the belt dust air locations were out by the feeder breaker, and any large source, continuous miners, and stuff, and so you have a much higher reading in this case because a lot of the dust creation sources are at the face.

MSHA at the same time did the same six mine study, and they had similar type results, meaning that the calculated values that they calculated that they should have at the face were a lot less than the actual recordings at the face.

And in two of these mines, you had a problem when in this case the belt entry intake was actually measured at 1.2 milligrams per meters cubed. The reason for that is the very low amount of air flow being brought up the belt, and in this case, about 4,000 CFM.

In mine six, they actually had another problem when the belt air supplied more air to the face than the intake, which is not allowed. NIOSH about three years ago did a study dealing with methane, and the calculation of methane components on a longwall face.

What you have here is the calculated methane at the tailgate, about 10 shields in from the tailgate, and not actually dealing with the interaction of the tailgate corner.

The shearer is the one in red, and that is its component throughout the day, without this evening shifting, and the green is the face conveyor or armored face conveyor amount of methane, and the component that came off of that.

What is of interest to the panel is the blue one, which is the belts. This refers to about a 3,800 foot belt, with coal on it, that was used on intake, and that is the component of the amount of gas that is attributed to coming off the belts and being brought to the headgate corner, and then being brought across the longwall face.

What you have here is the calculated total of all of them, and that one area is the back ground base. Unlike the dust emissions, it does match up a lot tighter because we are able to catch all of the sources of methane on a longwall face.

But we ended up -- and one of the conclusions that we had -- is that if you look at the belt, which is the blue, it represented about 17 to 18 percent of the total methane on the longwall face that actually came off the belt. That was our primary conclusion from that study.

The effects of contaminations on face concentration. The dust industrial readings are greater at the face than what was calculated for the simple fact that the places for the sampling location is (sic) out by a lot of the major sources of dust, and in this case, the feeder breaker is the biggest one.

Gases, unless there is a gas inundation, or an intrusion, or a large thing, or interaction with the gob, the actual face concentration should be very close to the calculated case, which bore out in the slide previous.

CO and CO2, again, the value should match what the calculated based on your intakes, assuming that there isn't DO source or any major concentration of CO or CO2 that is generated, i.e., something that is in by the sampling locations.

DR. WEEKS: Did you take samples in by the feeder breaker?

MR. KROG: I did not. The face -- going back, in these cases here, these values were all taken out by the feeder breaker, and those are actual face recording measurements. So that incorporates the feeder breaker. We didn't actually determine what the feeder breaker was.

DR. WEEKS: Well, it is giving you a mismatch, and your suggestion was because you had placed the sample, and if you moved the sample.

MR. KROG: Yes, if you move the sample location. I didn't actually do this. This is from 1996 data, and previous work with face with dust. But previous work since then has looked at what is the largest source of dust. Is it the feeder breaker and such, and this is one of the results.

They just wanted to know -- it was just looking at was the belt supplying a lot of the dust towards the face, and that was the key requirement. At that point, are you already going to fail by the time that you get to the feeder breaker.

And it is to show that the readings that they got were lower, the calculated were lower and were a lot less natural, and so a lot of the dust was actually created at the face.

Three entry gate road ventilation. That is the most common layout in the United States, with approximately 39, about 80 percent of the longwalls. Belts on intake or neutral outby historically or current.

The intake can be a track, or if there is no track, a trout, which is usually the primary travel way, and is also the primary escape way. This is a generic three entry system from one mine that supplied some data, but it applies to just generally all three entry mines in the United States.

The bulk of the air still gets brought up the track, which is a number two entry, and the number one entry on belts in this case supplies 20,000 CFM, and the track, 70, and the return is taking 90.

In this case the mine had 12,000 feet of gateroad, with 65 crosscuts. I represented that this one crosscut here represents about 61 of them, because you can't actually do it to scale. It does not look right.

So this is the summation of all the losses throughout all of the stoppings between the number two track and the number three return. They recorded about 35,000 CFM leaking out, and had 55,000 CFM at the last open crosscut.

Changing to -- well, let's just change the belt to outby neutral, in which case they wanted to dump 10,000 CFM at the start of it, and they figured that they would have gotten 10,000 leakage through the stoppings since now the belt is on a negative.

The same amount of -- this is assuming that your main ventilation system can supply the same 90,000 CFM at the same pressure gradient across your stoppings.

You get 90,000 being brought up your track, and 70,000 being brought up your return, and you get a reduction down to 30,000 of leakage, but the big numbers here is the last open crosscut reduced from 55 down to 40.

And at this mine, this was not acceptable for them during gateroad developments, and so they decided to add some more air. Well, in doing that, you would think that if you just needed to add another 15,000 to the last open crosscut, and so if you bring 20,000 up the track, you would be okay.

Well, that is actually not the case. Even though you are bringing up 110,000 up the track, you are not going to get the 55 at the front. The reason why is the amount of air that you are bringing up the track is going to increase your static loss down the track.

The intake air flow is increased down the track from 70 to 110,000. The pressure is RQ squared, and the R stays the same. So you are looking at 2-1/2 times the pressure loss of bringing the air up the track.

The next line here is the increased pressure across the return stoppings, and so just looking between two and three, the return is handling the same amount of air, and relatively these are all general statements, and these are just relative to the norm, which is the base case, and we call that one.

You are going to have 2-1/2 times the pressure loss down your track, and the same pressure loss down the return. So you would expect to see about 73 percent higher pressure across every stopping up the belt, or I'm sorry, not the belt, but up the track, number two track, and the number three return.

Quantity is PR square rooted, which because you would have 73 percent more pressure, you expect to see 32 percent more leakage across the stoppings. Your stoppings were at 35,000 and they are now going to increase to 46,000.

So that is another 11,000 CFM that you have to bring down the track. The problem with that is that you have increased the pressure again, and now you can also leak into the belt.

The end result when you iterate this or solve is that you come up with 130,000 CFM that is required to bring up the track, and 10,000 is dumped into the belts and outby neural, and you get about 15,000 leakage into your belt, and 50,000 leakage into your return, and that is just to maintain the same 55,000 CFM at the last open crosscut.

So in summary, when you look at it, the belt entry used to supply 20, and now it is exhausting 10 the feeder breaker, but actually when it is at the recovery room, it is up to 25,000 because of the extra 15,000 leakage.

The intake is increased at the recovery room from 70 to 130,000 and the return is also increased by 15. Leakage in the system went from 35 up to 65, and you can also add the 10,000 that you are dumping into the belt as well.

The requirement for this is -- and the big thing about the changing of the belt in this case, is that the mine had to supply from the main -- if you are looking from the sub-mains to the gateroad, to supply 40 percent more air and at over twice the pressure across their stoppings to generate the same 55,000 at the last open crosscut.

Looking at the intake air velocities, assuming it is a 15-1/2 foot entry by seven feet high extraction, you get about 108-1/2 square feet. So when the belt is on intake, and in the previous case, and when it was bringing up 70,000, you would expect about 650 feet per minute.

Under the final case, when it was bringing 130,000 CFM up the track entry, velocity is increased to approximately 1,200 feet per minute, and that is at the -- well, it is at the beginning of the panel, because you get leakage. It is not 130 when it actually reaches near the active face.

But if you consider the man trip ends up blocking 25 percent of the cross-sectional area, then that air velocity intake around the man trip can get up to 1,600 feet per minute.

Three entry longwall extraction in eastern mines, and here is a big thing, is that you can't take a thing and apply it to all 49 active coal mines in the United States that use longwalls, because each coal bed has its own unique features.

This is referring to eastern mines, i.e., Northern Appalachian and Central Appalachian Basin. Belt air methane liberation is a significant contributor to longwall face methane readings. In the previous -- about 10 slides before, the belt represented about 17 to 19 percent of the methane recorded near the tailgate corner of a longwall.

The use of intake belt air becomes a

hindrance as the longwall panels length increase, i.e., you go from 10,000 to 14,000, to 15,000 feet in length, because you have that much more belt and that much more time for the coal in the belt to de-gas on its way out of the mine if you are going to bring that air to your face.

An example of one mine, and I will go to the slide here, they had a 14,000 foot long panel, and they started it up, and within a few hundred feet of startup, when they are starting up the full production, they started getting gassed out on the longwall face.

And the reason for it is they were recording .7 percent methane coming up the belt. They were bringing 25,000 CFM up their belt, and they were getting loaded to about .7 percent on that, and that to them was unacceptable and they needed to change.

Since they were so close to the bleeder system, they knew that their exhaust system could handle getting rid of large quantities of air, but they just had difficulty supplying it down the 14,000 feet of gate road.

What they ended up doing was converting the number three return to an intake, and taking the belts on outby neutral. They noticed a lot of advantages by doing this. One, they were able to supply a lot more air to the headgate, and increased air flow along the longwall.

This is to show the before, and this is when it was on intake, and this is when the belt was on return. The same 25,000 was being brought up to the face, and then 25,000 was being brought out.

The intakes stayed the same at 80,000 CFM. The return went from exhausting 30,000 to bringing in 50,000. The air flow at the number 10 shield on the longwall face went from 55 to 80,000 CFM, and at shield 139, which was about 10 shields in from the end of their panel, it went from 75 to 60. So they increased the air flow along the longwall panel quite significantly.

The key thing to look at is how much air was supplied to the headgate T-junction. In the previous system, they were able to bring 75,000 CFM up. Now they are able to bring 105,000 CFM up, which is a 40 percent increase.

The advantages for them changing over in this particular mine, and changing over to using belt outby, is the belt is on outby. They have a secondary isolated intake, and I should note that to do this that they had to go back and reinstall about six overcasts to allow them to change over their ventilation system.

They had a second isolated intake, and so they have a primary and secondary, and so their primary is their track, and their secondary intake was their number three, and that was now an intake.

Because there (sic) is two parallel intakes, the headgate corner is now at a relatively higher pressure than it was before, because the belt on that is only moving 25,000 out. So really you are not pressurizing it. I don't want to use that term, but it is still negative pressure because the line is on return.

But you have a higher relative pressure at the headgate corner, which allows multiple things. You can increase your air flow quantity across the face, assuming that your bleeder system or main return air system can still get rid of the air.

But the biggest thing during daylight is that they had an increased amount of air at their headgate corner, and they were able to increase the amount of air that they were able to dump into the bleeders as a sweetener.

The reason for this is as you know panels are getting longer, and wider, and there is more and more gob air. And you are taxing the bleeder system and you are removing more and more of the methane. So to allow that to happen, you still have to add sweetener to the bleeder system, and the best part to do that is actually on the active longwall panel.

So to summarize, eastern mines, three entry gateroads in general have a difficult time during development with the belt on outby neutral without using pre-methane drainage or even extensive pre-methane drainage.

The case that I showed that had 130,000 CFM coming up the track, to them when they say it is economic and everything is interconnected, they are under the belief now that they if they could do even more and more methane drainage that they can reduce that number, because they won't require as much air at the face if they can reduce the amount of in situ methane in the coal.

Three gateroads during panel extraction have over the past, and this is in the eastern coal mines, have over the past few years almost gone to exclusively using dual intakes with the intake on outby neutral.

Western mines and Illinois mines are a little different. In fact, western mines, if you use the Utah mines, five of them being on two entry gateroads, the belt air is required to be on intake during longwall extraction.

They also have the problem with spontaneous combustion of the coals out there, which changes the generalized practice as it is applied to eastern mines.

The Illinois Basin also has a different case, because their coal, unlike coals in the east, don't de-gas as much on the belt outby. So for them using the same 14,000 foot belt, they are not going to get -- generally they are not going to get as much gas coming off their coal, thereby increasing the methane load coming towards the longwall face corner. So the belt air does not bring excessive methane to the working areas, and questions?

DR. TIEN: Robert, that is quite interesting. I just have a general question. Do you by any chance have data, pressure drop data, for the 14,000 feet longwood panel?

MR. KROG: I do not on me, no.

DR. TIEN: How about a cross-face?

MR. KROG: Pardon?

DR. TIEN: Across the longwall panel face? Do you have pressure drop data on that?

MR. KROG: No, we didn't take that pressure reading data.

DR. TIEN: Now you covered the longwall setup pretty well. Did you have any chance to work on the continuous mining section panels?

MR. KROG: No, I was told to just deal with using belt air on longwall faces. I didn't deal with, or to get data on all the -- are you referring to room and pillar sections that use belts?

DR. TIEN: I am talking about the panel and using the continuous mining method?

DR. BRUNE: Development sections.

DR. TIEN: Development sections, yeah. Have you had a chance to use the belt air, either a blowing system or ventilation system, or return system?

MR. KROG: Are you talking mains, sub-mains, or --

DR. TIEN: No, just the panel, the long panel.

MR. MUCHO: Driveage.

MR. KROG: Oh, okay. No, we did not get into that. I'm sorry. I didn't cover that section.

DR. TIEN: It might be helpful because we are still talking about 50 or 45 percent using continuous mining methods.

MR. KROG: Yes.

DR. BRUNE: Robert, just one question about definitions. Is outby neutral identical to belt on return?

MR. KROG: Belt on return, yes.

DR. BRUNE: Is that the same? I think we need to make that clear. The other question I picked up is that you mentioned that in western mines that have two entry development during longwall extraction, belt air is required to be on intake; is that correct?

MR. KROG: I'm sorry, I did not mean required. Belt air is used on intake so they can supply enough air.

DR. BRUNE: Right, it is typically used. It is not a requirement.

MR. KROG: It is not a requirement.

DR. BRUNE: I just wanted to clarify that.

MR. KROG: If you worried about getting gassed out, it is typically that those mines use belts on --

DR. BRUNE: I understand that they typically do, but I was just tripping over the requirement.

MR. KROG: Sorry for my incorrect use of the word.

MR. MUCHO: I would like to debate, Robert, the statement as far as the generalities that the use of intake air becomes a hinderance as the longwall panel increases in length.

MR. KROG: Based on which coal you are using.

MR. MUCHO: Generally, for the reasons that you have given, that's true, but you are assuming there that -- for instance, I am bringing the belt air in outby the mouth of the panel, or at the mouth the panel, and so it is traveling over the length of the belt.

So as I increase the length of the belt, I increase the gas and so on, and so forth. Really, it comes down to the quantities as you showed in the one equation.

MR. KROG: Yes.

MR. MUCHO: And the concentration of the contaminant, and the quantities of the belt air, and the contaminant of the other intake lines to make the face air, and its contaminant and quantity.

So let's say for longer panels, ventilation schemes such as if I would point feed midway up the panel, where I am now bringing back quantity in only on half of the length of the belt, and maybe bringing in a very large quantity at that point, a large quantity having a bearing on pollution effect, et cetera, on face air, then I get a different answer from that ventilation scheme from the generalized statement that we have here.

MR. KROG: The generalized statement is assuming the entire length of the belt is being brought up to the face. If you are going to mid-panel or a thousand feet in front of it, and dumping that, you completely change the methane equation.

MR. MUCHO: I understood that is not fully applicable as a generalization in all cases, on the depending on the ventilation system?

MR. KROG: The case that I showed, that .7 percent, that is a case where you are dumping 3,000 tons per hour on to a belt, and pulling that belt out in the same 25,000.

So the air flow is only moving about almost 300 feet per minute, and so there is not a lot of air moving up the belt. So, yes, that is a big change in the amount, and also the coal was de-gassing that whole length at the time.

DR. GALIZAYA: I have another question. Again, a general question. When you talk about western mines using a three entry system, could you elaborate a little bit more on the reasons for some of those mines using that system?

MR. KROG: I was under the assumption that the two -- it was about 1984 when Cottonwood Mine fought -- no, not fought, but took legal action to allow them to go to a two entry gateroad system was based off of the reduction of bumps out in Utah, which was very deep mines.

And you physically can't have a three entry system and keep the middle entry open under a yield pillar design with a two gate road. What I am referring to is the two entry longwall here. This is a yielding type pillar, which doesn't leave the stress abutment, which doesn't allow the huge bumps to occur in the mines.

So they are limited to having two entries. They also have or they can have some higher heights than required here so that they can bring -- so that the two entries have enough air quantities to allow them to mine.

But under my assumption, the two entry is primarily a result of ground control issues not allowing a three entry system. So the Utah mines, that was a court settlement that came out in '84 to '86.

MS. ZEILER: Okay. Thank you very much, Robert. Our last NIOSH presentation for this meeting will be from Fred Kissell, who will speak to us on mine escape issues.

(Pause.)

DR. KISSELL: For the record, my name is Fred Kissell, and I am one of those recycled retirees from NIOSH, brought back to discuss research that took place 15 to 20 years ago, and fortunately I have some memory of what happened and so I would like to impart that with you today.

My task is to talk about four research studies that were conducted, and of those four, the first was to pressurize intake escape ways -- you can see the lead slide -- to reduce the infiltration of smoke.

The second study dealt with what are the major hindrances to escape from mine fires, and I had some pretty stunning results I thought with regard to the impact of smoke, versus the impact of other factors.

That is the first two. The last two studies were a fault tree study, and a systems analysis study, where we attempted to get our arms around the problem of escape as a whole. In other words, basically to recognize that there are many factors impacting escape, and whether you get out of a mine depends on literally dozens of factors.

So the question is which of these factors are more important and which are less important, because that is really crucial if we are to improve the probability that miners are going to escape during a fire.

So, anyway, having said that, I would like to deal with the first study. I am told that this lower right-hand button is the one to push. The original idea to pressurize intake escape ways to reduce infiltration of smoke came from Don Mitchell, and it was in the book, Mine Fires.

And he suggested in the book that if you checked off the intake escapeway, you might raise the intake escapeway pressure and reduce infiltration of smoke.

And we had invented the parachute stopping years earlier, back in the early '70s, as a way of -- for a temporary check curtain that found its way in uranium mines when uranium mines were still in business.

And we speculated that a parachute stopping would work well as a temporary check curtain. It goes up in just a few minutes, and leaks less than a regular check curtain. So the question is could you use that to check off an intake escapeway, and if you raised the pressure of the intake escapeway, how much would it go up, and would it really work.

So that is really what the project was all about. This was done by Bob Timko and I, and published in '91. A typical layout. We visited six mines, and in those six mines, we conducted 10 tests in different sections.

A typical layout was this in line B. This was a four entry development. The panel belt was on return, and for the test, what we did is with the parachute down, first of all, what we would do is we walk out by and measure the pressure at each door between the intake and the adjacent entries, and just throwing a tube through the door and measuring the pressure with Magnehelic.

And we would walk out by as far as we possibly could to either the mains or sub-mains, several thousand feet. And then what we would do is we would throw up the parachute, which just took a minute or two.

And then we would go back and remeasure all of those door pressures between the intake escapeway and the adjacent airways to find out how much the pressure went up, and was it considerable, and we would walk out by it to find out how far the effect lasted as well.

So these were our results, and this is typical. They were all about the same. Basically you could see with the parachute down, we measured the pressure between the intake, and the escapeway, and the belt, and you could see basically the intake escapeway was higher pressure than the belt. It was about the same as the track.

We threw the parachute up, and typically you would get an increase in pressure of about a tenth of an inch water gauge. Here again the pressure between the intake escapeway and the belt, and here the intake escapeway in the track.

Interestingly enough the results for all of the mines and all of the tests were roughly similar, and we basically got a tenth of an inch water gauge improvement.

It is also interesting to note, and I don't have really a slide for that, but what happens is that in eight out of the ten tests the pressure in the intake escapeway was already higher than the pressure in the belt, whether or not the belt was on intake or return.

It was a little higher and so the belt was on return, but in general the intake escapeway was at a higher pressure than the belt, which kind of surprised us, but that is the way that it turned out.

DR. MUTMANSKY: Fred, a comment. Because of the direction of the air as shown, go back to the slide where it showed the mine layout. You see the intake air is coming up into the section, and the belt is coming back from the section. It is always going to be a positive pressure difference between the intake and the belt on that section.

DR. KISSELL: On that section, right.

DR. MUTMANSKY: Whereas, if you reverse the belt, that will be where you have the problematical situation. Did you look at it under those conditions?

DR. KISSELL: Oh, sure. In most instances, in most of the tests, the belt was on intake and not on return. For most of the tests the best was on intake and the intake escapeway pressure was still higher than the belt.

DR. MUTMANSKY: Okay. Good.

DR. KISSELL: I really have no explanation for that other than the fact that the belt structure itself has a real big impact. But the fact of the matter is that the intake escapeway pressure was higher than the belt in eight out of the ten times. Now, not by much. Just by a couple of pascals, but it was higher.

DR. TIEN: Fred, on the previous slide, you have covered -- oh, this was the vertical or the distance. Okay.

DR. KISSELL: Thanks for mentioning that. I forgot to mention that essentially this effect, this inch of water gauge that you buy by erecting the parachute diminished as you went outby, but in general there was some effect up to about 4,000 feet outby.

DR. TIEN: And also did you have a chance to characterize the leakage before and after the test? The leakage of the stoppings.

DR. KISSELL: No. We measured section air flow in addition to measuring pressure through the doors. Interestingly, the escapeway air flow fell by 70 percent. In other words, the leakage past the parachute was 21 percent.

But when we measured the face air flow, it only fell by six percent. So obviously what was happening was that air coming down the intake escapeway was being rerouted to the other airways, and then still going to the face nevertheless. That is what was happening.

So essentially we weren't really reducing much of the air flow that went to the face, but we were rerouting it into adjacent airways, and that sort of makes sense looking at it and considering how leaky mine stoppings are.

MR. MUCHO: By that you mean leaking basically?

DR. KISSELL: Yes, and that sort of speaks to its ability to keep out smoke as well, because clearly if you are leaking into a belt, you are not going to have smoke moving in the other direction.

The conclusions from that study were parachute stoppings helped to keep smoke out of the escapeway if the fire source is not in the escapeway. Now, that is a big if, and it will depend on the mine, and it will depend on the number of entries.

But basically that was our conclusion, that the entry water gauge was pretty considerable compared to the existing pressures, and it would actually work quite well to keep smoke out of the escapeway if the fire source was not in the escapeway. The next study --

DR. BRUNE: May I ask a question before you go to the next study?

DR. KISSELL: Yes.

DR. BRUNE: Fred, what would be the impact of putting up the parachute, the impact on the overall mine ventilation system? I am thinking in case of a fire, the last thing that you want to do is change or make significant changes to the mine ventilation system.

And that would be a concern to me as a mine operator to put up a parachute and possibly change or reverse the air that travels over the fire.

DR. KISSELL: I don't think there was much of a change at all. We may have made some measurements back in the mains and the sub-mains, and didn't see any difference. Frankly the amount of air reaching the face didn't change.

And if it did, I would have said maybe there is an impact on the mine ventilation system, but since the amount of air reaching the face only changed by six percent, that is a pretty small change.

And all it did was reroute the air into adjacent airways. So my guess -- and Rob might remember whether we took any measurements in the mains. Did we?

MR. TIMKO: No.

DR. KISSELL: We didn't? Okay. My guess is that there is not much of a change frankly.

MR. MUCHO: Fred, before you move on, I would like to stay with this one. I will ask the same question that I asked in Washington of someone else, and about the same talk.

This was brought up before the 1992 advisory committee, and the 1992 advisory committee recommended that this type of approach be used for e-ability, et cetera, and then it sort of disappeared from the face of the earth until here we go again today with it.

Do you know why that disappeared? Do you have any feel for that, and why this has not caught on as a concept for escape?

DR. KISSELL: Well, although it was an interesting study and I think it worked well, I had mixed feelings about itself. In general, I think it is better to take action to prevent mine fires from happening in the first place than it is to take after the fact actions.

And I think back in the early '90s there were more fire sources in escape airways than there are now, because there is more -- well, you can't put, for example, a compressor in an intake escapeway.

MR. MUCHO: Right.

DR. KISSELL: And so just the fact that

there were a lot of fire sources in the intake escapeways at the time may have mitigated against using this, because frankly if there is a fire source in the intake escapeway, and you throw up a parachute to block it, you are going to have -- you basically are going to have more leakage into the adjacent airways that you want to escape out of. So it would create a serious problem.

MR. MUCHO: Right. Your previous slide, if the fire is not in the escapeway, and of course the assumption there is that the miners know where the fire is located, and it is or is not in the intake escapeway, and that would dictate their actions.

DR. KISSELL: Right.

MR. MUCHO: And with communications today, that is the whole big thing, but --

DR. KISSELL: Traditionally, nobody has known where the fire was anyway if you know what I mean. I am thinking --

MR. MUCHO: It varies in some cases. I mean, the '58 fire, they knew where it was at.

DR. KISSELL: Some people may know it, but the people inby may not. Any more questions?

DR. TIEN: Can I make a general comment? Usually we refer to leakage as being an undesirable factor, or we try to reduce leakage, but in this particular situation, leakage will actually help you to redistribute the air.

DR. KISSELL: Well, yes and no. I mean, if you had less leakage, your pressure difference between the intake escapeway and the adjacent airways would be even higher than an inch water gauge. So it is really a mixed bag.

DR. TIEN: It depends on the situation, yes.

DR. KISSELL: Yes. It is really a mixed bag. Anymore before we go on?

(No response.)

DR. KISSELL: The second study we did, and this is a study that Dave Litton and I did, how smoker hinders escape from coal mine fires, and this came from perusing through some of their smoke optical density, carbon monoxide measurements that I was doing after they conducted one of their conveyor belt burns.

And what happened was that I ran across a table that they published that gave carbon monoxide values at various optical density values. This is basically an optical density of a tenth of a meter, or tenths per meter. The units and optical density are reciprocal meters, and with the visibility of 26 feet.

And I looked at this table and a couple of things struck me at the time, and we are talking about back in 1990 or so. First of all, is that the CO concentration for a given visibility level, for approximate purposes, they are within fairly close tolerances.

In fact, there is more difference between CO flaming and CO smoldering. That was the first thing that I noticed. A second thing I noticed is that for visibility of 26 feet, the CO levels here are remarkably low. They are just remarkably low.

And these work in a reciprocal manner. In other words, basically if we can imagine that smoke is four times as dense at four-tenths per meter, that leads to a visibility of a fourth of that value, or about 6-1/2 feet.

And essentially leads to, say, for an SBR belt, a CO concentration of 15 parts per million. In other words, the numbers were really, really eye-opening for me, because essentially people were running out of visibility at relatively low carbon monoxide values.

And so the question here was, well, what exactly is preventing people from getting out of mines. Is it the carbon monoxide or is it the lack of visibility.

And I decided to investigate this a little bit further, and Dave Litton and I put a little project together. These numbers basically on CO and on optical density come from various meters that they use, an optical density meter of some sort.

So what we did is we set up -- I think it was an SBR belt burn in the Lake Lynn mine, with a couple of square yards of conveyor belt, and we set up a video camera downstream of the belt, and at 25 feet from the video camera, we put a scarecrow of some sort.

And then between 25 feet and the camera, we put up wooden placards with numbers written on them, and it is sort of a standard procedure that people use for measuring optical density in fires.

So we also measured the carbon monoxide concentration at the same time, and later when we looked at the video tape from the camera, we could see essentially the smoke getting thicker and thicker, and eventually the scarecrow would disappear, and then the various signs at various distances would disappear.

And so we could get a feel for what the visibility was, and since we measured carbon monoxide at the same time, we could get a feel for where the carbon monoxide was. So essentially we got this. The outer curve here, the longer one, is essentially from their measurements of optical density and from the measurement of carbon monoxide.

And our direct visual observations using a video camera are the shorter curve right here. They correlate reasonably well, but the stunning feature of this frankly is the fact that at relatively small visibilities -- and by the way, about 12 feet visibility is the generally accepted minimum for escape from building fires.

That is basically a number enshrined in general escape. You need 12 feet to get out. But underground 12 feet corresponds to roughly a concentration level, a CO level of about 30 parts per million.

Which means essentially that smoke is the major factor preventing escape from mine fires, and not carbon monoxide. Now people may die of carbon monoxide. When there is an autopsy, there is carbon monoxide in the blood.

But the main factor that prevents these folks from getting into fresh air is the loss of visibility and they get lost. That was really a very surprising thing to us, and to examine it a little further, we set up a little model, and essentially established an entry with a fire over here, and that fire produced contaminants of a concentration of C Sabeth.

There is some stopping leakage into an escapeway that has air flow QCB, with a leakage QCL, and the contaminants in the escapeway are calculated in a rather straightforward fashion using simple proportions here.

So, anyway, using that model, and keep this model in mind, because we will be referring to it in a subsequent paper, too. But what I did now is plot visibility versus leakage into the escapeway, and over here we are plotting carbon monoxide and we are actually plotting oxygen as well.

And you can see that there is some common sense here. As the leakage goes up, the visibility goes down, and the carbon monoxide goes up, and the oxygen goes down. That is all that we are plotting here.

Now, our visibility minimum of 12 feet I am plotting right here, and our CO critical maximum, the IDLH level, this is fifteen hundred parts per million back in the early '90s, and I know that it is lower now. These numbers keep going down.

But that was the number basically that was relevant then. We can see from this curve interestingly enough that as the leakage changes, we have reached the visibility minimum at 200 CFM leakage into the escapeway.

In other words, we run out of visibility at 200 CFM leakage, and as the leakage goes up, the CO also goes up, but we never reach the CO critical maximum even with 20,000 CFM leakage.

In other words, a leakage value of one percent of 20,000, we have already run out of visibility, and at 20,000 leakage, we haven't even reached the CO critical maximum yet.

In other words, we run out of visibility at values of leakage, a percent or less than the value that it takes to do us in with carbon monoxide.

Now, on that basis, the paper recommended the use of lifelines, and today we have lifelines, probably one of the best things that could have happened in a long time, and I think this paper also led to the NIOSH recommendation a few years ago that NIOSH or rather MSHA require directional lifelines.

So lifelines have had a tremendous impact, I believe, in promoting mine safety, and improving escape from mine fires.

Our conclusions? Of course, I mentioned

lack of visibility and smoke, and the accompanying fumes are the greatest obstacles to safe escape. You saw those black clouds coming out of the conveyor belt burn at Lake Lynn, okay?

You would have been amazed at how low -- I don't have any numbers here, but you would be surprised at how low the carbon monoxide concentration in those clouds was, a couple hundred parts per million probably.

So it is lack of visibility that is really the primary problem, and it is really good that we have come around as a nation to dealing with that. Any questions before I go on?

DR. WEEKS: What was the material that you were burning to make this smoke?

DR. KISSELL: SBR belt. But it really doesn't matter because essentially all the concentrations for the various belts, and even coal, they are all relatively about the same.

That is what surprised me. There is generally for most of these burning materials that will burn in mines, with the exception of wood, which is a little different, a CO to smoke ratio, CO to optical density ratio, and once you specify the CO, you pretty much know the optical density and vice versa. That's the interesting thing about it.

DR. BRUNE: And is it correct that you had oxygen enriched burning conditions and not fuel rich?

DR. KISSELL: Yes, that's right, 21 percent oxygen and whatever is normal. Yes, Jim?

DR. MUTMANSKY: I believe the human reaction to CO though is cumulative; that is, regardless of what level of CO you are at, you begin to accumulate the problem in the hemoglobin of the blood, and it gets worse over time. Did you take a look at that particular effect?

DR. KISSELL: No. We are looking basically at all short term effects, and whether you can see this minute or can't, and that's why we used the IDLH level rather than any kind of an SDL or long term level.

It is probably in fact why the autopsies of these fallen miners showed fairly high CO levels in the blood, too, because they had been breathing it for a long time.

MS. ZEILER: Jim, you have to move up to the microphone, please.

DR. WEEKS: In a mine fire what would you say is the nature of fuel status if you get smoke? Would it be coal?

DR. KISSELL: I can't answer that. You would have to turn to the fire guys to do that, and essentially, the fires -- they have explained that the fires that they have used or they have started, was either a coal fire or a tray fire, and they burned primarily the belt, but started a coal or tray fire.

The fire that we built at Lake Lynn started, I believe, with strip heaters in a pile of coal, and then went from there to burn the belt.

DR. WEEKS: The issue is whether it is worthwhile to worry about the optical density of smoke from the belt, and if we produce that would it make any difference?

DR. KISSELL: I would have to take a look. Here is coal versus SBR belt, and PVC belt, and neoprene belt, and it is really all in the same range.

DR. WEEKS: I am assuming that something can be done to the belt where there would be no smoke?

DR. KISSELL: Sure, if it didn't burn in the first place, it wouldn't produce much smoke.

DR. WEEKS: Well, that's true, too, assuming that it is going to burn and produce this smoke. But it doesn't contribute much to the overall smoke, then if you worry about reducing the amount of smoke on any particular belt line, then -- well, if the smoke --

DR. KISSELL: I think you reduce the smoke from belts the same way you reduce the toxic acids from belts. You have a belt that doesn't burn in the first place.

DR. WEEKS: Yes, but I am assuming that it is going to burn for purposes of this issue.

DR. KISSELL: I can't answer that. I really don't have any research to address that issue.

DR. WEEKS: Well, that is the issue, and is it worthwhile worrying about the optimum density of the smoke resulting from the belt burning.

DR. KISSELL: I don't know. The simple answer would be basically if you can find a belt that doesn't burn, it reduces the smoke and reduces the toxic acids.

DR. WEEKS: You said that three times. We are getting there.

DR. BRUNE: Based on your conclusion would it be fair to say that an optical density or smoke obscuration sensor is a better indicator of a fire source than a CO sensor?

DR. KISSELL: You would have to talk to Dave Litton about that.

DR. BRUNE: I am asking you.

DR. KISSELL: Yes, and I don't know. They have done some research on smoke sensors, and I think they find that a smoke sensor, yes, does in fact detect a fire more (sic) earlier than a CO sensor, yes.

But basically whether they got to the point where they could say that these things were reasonably reliable and didn't have a lot of false alarms, that is a problem, because of so much dust in conveyor belt lines, anything that depends on optical sensing is really problematic. That is the difficulty. But where that research stands, I don't know.

DR. BRUNE: Okay. We will talk to Mr. Litton about it.

DR. KISSELL: Okay. The third study is evaluating those factors that influence escape from coal mine fires. This is a study that Gerrit Goodman and I did back in the late '80s, and this study and the next one are both essentially system studies in an attempt to get our hands around what factors impact escape, and what factors are more important or less important.

And the first approach that we took was essentially a fault tree approach, and I am sure that all of you have heard of fault trees. They are used extensively in the chemical, aerospace, and nuclear industries, to analyze basically the probability of failure.

And the strength of a fault tree is that you can establish a top event, which is the failure of the system, and then establish so-called starting events that contribute to the failure, and given the probability of starting events, you can calculate a probability of failure.

And given changes in the probability of starting events, you can essentially calculate the overall probability of failure. And it struck us that this might be a powerful technique to look at mine fires, because we could say to ourselves, well, we can establish a probability that the AMS system would fail, and a probability that self-rescuers would fail, and a probability that stoppings would leak more than normal.

And so now the question is if we change these probabilities by a fixed amount what is the overall impact of these individual changes, okay? Fault trees have not been used much in the mining industry, and in this regard, we were sort of blazing new ground.

But the results of this study, and I think the next study, were pretty substantial in pointing us into the proper directions. Here is an example of an ultra-simple fault tree, and not the one that we used, but it has only got a couple of levels.

Basically, we are hypothesizing in this tree that there is a so-called failure to escape, a probability associated with a failure to escape, and through this logic tree, we can say that this results either from being lost in smoke, or a failure in a self-contained self-rescuer.

Now if we had probability values for lost in smoke, and a probability value for SCSR fails. Through the OR gate, we can calculate a failure to escape probability.

Now, of course, whether the SCSR fails is dependent on other factors, and so now we can work our way down through the fault tree at various so-called starting events and vary the probability of the starting events to see what the probability of failure to escape is.

Now the actual tree, I am not going to show it to you. It had over 20 starting events, and about 20 levels, and it is really too much to fit on a small slide here, but I think you get the general idea.

Let me give you some results from our fault tree analysis. For example, we looked at top event values for changes in SCSR training escapeway knowledge. That is what this is. And these are the top event values in this three-by-four matrix right here.

And here we are plotting basically the probability that there is going to be some error in putting on and using, or functioning of the SCSR, anywhere from a tenth to .93.

There is another probability of finding the escapeway, and that you will get lost and never get in the escapeway in the first place, and we varied that from a tenth to nine-tenths.

And you can see basically -- well, first of all, there is (sic) some common sense things here. If you don't find the escapeway, it doesn't matter whether you have much or any air in the SCSR.

Correspondingly, if you have a high error in the SCSR, it is more than likely that this SCSR is going to fail, then obviously if there is no change in whether you get out, depending on whether you find the escapeway or not.

But the other interesting thing here is that when we see a high probability of finding the escapeway, and a low SCSR error, we have essentially a probability of failure and not getting out at .57.

But if we have a higher -- essentially a higher probability that the SCSR is going to fail, and a low probability of finding the escapeway, the chance of failure in getting out is .63.

The bottom line and what I am trying to say here is that the fault tree emphasizes how little just a few changes impact the overall result. Here basically we have reduced our SCSR error.

We found a high probability of finding the escape way, and all we have done is improve the chances of getting out, or rather improve the chances of getting out -- or actually this is the chance of failure. Basically, we have lowered the chance of failure from .63 to .57.

DR. WEEKS: I am a little lost here. Where do these numbers in the middle come from?

DR. KISSELL: This is the top event on the fault tree.

DR. WEEKS: And how did you get this?

DR. KISSELL: Basically through the process that I showed you before. Basically, calculated from sub-events on the fault tree.

DR. WEEKS: What is it that goes before the .63? I mean, I want to put some numbers out there, equals .63, and what is that number?

DR. KISSELL: That is the probability of not getting out.

DR. WEEKS: And where did it come from?

DR. KISSELL: The calculation that we did in the fault tree. In other words, basically we entered --

DR. WEEKS: What do these margin numbers do?

DR. KISSELL: This is basically the starting events in the fall tree, the probability of finding the escapeway. In other words, basically we entered so-called starting events into the bottom of the fault tree.

One starting event, for example, is the quality of SCSR training, and whether the SCSR is going to fail, and whether the AMS system is going to work, whether the stoppings are going to leak, whether in fact people are informed in time.

DR. WEEKS: So the path for the .1 and the .93 to the .63 is somewhere else?

DR. KISSELL: Right. It is all basically all in one tree, and this essentially, we are just taking a little segment out of the tree, and trying to illustrate the point that changing just a few factors doesn't make much difference. That is what we are after here.

DR. BRUNE: So if I understand this correctly, the probability of escape, or getting stuck in the mine, the reverse of that, is mainly dependent on a functioning SCSR, and not so much on finding the escapeway in the first place. Is that correct?

DR. KISSELL: Well, let's say, for example, that our SCSR error is quite low. The probability of -- well, they are about the same. Basically, the chance of not getting out, you can reduce it from .63 to .57.

If your SCSR error is low, the probability of finding an escapeway is high. You can change it, but basically if the probability of finding the escapeway is high, you can improve by an equal amount essentially by changing your SCSR error. So this is pretty -- they are about the same.

DR. WEEKS: What makes those numbers go higher or lower?

DR. KISSELL: I will come to that.

DR. WEEKS: Okay.

DR. KISSELL: I will come to that. They are not very optimistic numbers, okay? That's what I am saying. You can also do something in a fault tree called obtain a minimum cut set, and a minimum cut set is the smallest sequence of events leading to failure at the top event.

In other words, not getting out, and we found that in minimum cuts that fatality events had common features. First was the delayed evacuation. The second was the lack of lifelines. The third is confusion in locating the escapeway, and the fourth is malfunction of an SCSR.

Now considering what we have learned in the last 15 years, this seemed to be reasonably accurate. Now there are other events that involve five or six items that essentially lead to a fatality.

But the value of the fault tree here basically is giving us a general perspective on things, rather than a specific perspective, and the general perspective here is that when it comes to escape from mines, people have always been looking for a silver bullet, a great white hope, and at first maybe it was a self-rescuer, and then it was atmospheric monitoring systems.

Now it is maybe belt air, or maybe it is something else, and the message from the fault tree is essentially what it takes to make substantial improvements in escape are a number of things working together. Not necessarily one big change, but rather modest changes in everything.

And unfortunately we have implemented lifelines, and we will have less confusion in locating the escapeway. Malfunction means poor training. We have had better SCSR training over the years. So I think we have seen some improvements in this already.

DR. TIEN: Fred, are you assigning them with equal weight, or are you listing them in the order of significance?

DR. KISSELL: It was hard to worry about significance in this particular study, because remember that for the starting events in the fault tree, we had to establish essentially arbitrary probabilities rather than get them from some data.

And what we are depending on here are the changes in probabilities, the 10 percent change, the 15 percent change, and the probability to draw our conclusions.

And under those circumstances it was really hard to draw some conclusion here, with one exception. Delayed evacuation showed up everywhere. If you were to put your thumb on one particular thing, and I think as you read the accident reports that have taken place over the years, even the most recent one, delayed evacuation was a common feature everywhere.

DR. WEEKS: That is almost the pathology. I mean, the reason that you didn't get out of the mine is because you stayed in the mine.

DR. KISSELL: Well, yes, but that is also true for fires everywhere. People who delay getting out of their house because the house is on fire, and because they wanted to save a pet, or they wanted to go back and recover their wallet, or their pictures of relatives, end up dying in the fire.

DR. WEEKS: Well, you could practically blank order some of these features. You can say, yes, all of them together makes (sic) a difference, but some of them are necessary, like evacuation.

DR. KISSELL: Well, we are going to deal with rank order in the next study, but it deals a little more powerfully with that issue. And I see the value of the fault tree here. The main value of the fault tree is essentially pointing out that there is no silver bullet here.

There is no magic solution that you can put your foot on and say now I have taken care of it. It just is not going to happen. And just to close up, I wanted to point out -- and your questions really in some ways spoke to this, reducing the top event.

In other words, if there is a chance that you are not going to get out, and this is one typical example. I am not saying that this is the only way to reduce the top event. Other than delays, you can change these factors.

But reducing the top event by 75 percent required for our particular fault tree -- one, minimal delays; an excellent chance to finding the escapeway; excellent SCSR training; and stopping the resistance to smoke leakage and fire damage. That reduced the top event by 75 percent, which is the kind of thing that I think we are looking for.

Conclusions. With the exception of delays, single factor changes have minimal impact. That is essentially the conclusion from the fault tree studies. Yes?

DR. TIEN: Can you go back to the previous slide. The last sentence, I was a little bit unclear on that.

DR. KISSELL: Stopping resistance to smoke leakage and fire damage. Well, clearly if the stoppings leak, then you will have more smoke and more fumes into the escapeway, yes. The ultimate was at Aracoma, where there was no stoppings.

DR. WEEKS: Let me nitpick a bit here. With the SCSR, you are assuming that they were; is that right?

DR. KISSELL: Yes. We didn't build that in.

DR. WEEKS: You didn't build that in?

DR. KISSELL: We didn't build that in. We just assumed that they were, which of course is an approximation. Any more?

(No response.)

DR. KISSELL: Okay. Keep the word delays in mind, because in some ways the most interesting study is coming up, and it really revolves around delays as an issue.

And this was a more explicit attempt to rank factors impacting survival during mine fires. It was a study that I did in conjunction with Bob Timko and Dave Litton. And the idea for this study came from a paper written by a guy named Roberts, who worked for the British Coal Board, who published a paper in South Africa, called the Systematic Strategy for Assessing Fire Protection Measures.

And what Roberts did is he established an equation to calculate what he called a survival index. And his survival index was basically -- and the unit by the way here of survival index is minutes, and the survival index is essentially the time it takes for the toxic gases to reach the miners, minus these three factors.

And the factors are the detection time for the fire, the decision time to decide to get out, and the travel time for the miners to reach a point out by the fire where there would be safe.

So basically as these varied, hopefully the combination of the three, these three times, was less than the T-Toxic, and the survival index would be positive, but it was really in my mind a fairly good start in trying to figure out whether or not you had a safe mine, and what contributed to the safe mine.

This was as far as Roberts took it, and as I looked at this, I thought to myself, well, this is a good start, but what about atmospheric monitoring systems, and what about stopping leakage, and what about whether or not you wear a self-rescuer, and what about whether or not you have lifelines.

What about all the other factors that are important in the escape of mine fires. Could I convert these into time. Could I convert stopping leakage into an equivalent time. Could I convert whether or not you wear a self-rescuer or use a lifeline into an equivalent time.

If I could convert all of these things into time. Now, on the basis of time, I could do a comparison between various alternatives in terms of escaping from a mine fire. This way I could essentially optimize the system.

And in this regard, this was a system study that tied together the elements of the system mathematically. Now can I equate stopping leakage and translate that into time?

Well, it turned out that I could. Could I translate mine fire growth into time? It turned out that I could, and let me give you an example of how this works.

Let's imagine a fire growth curve, and here basically on the X-axis, and that is for measuring time, and on the Y-axis, on the ordinate, we are measuring either carbon monoxide or we are measuring the optical density of the smoke.

And you can see basically as the fire grows the carbon monoxide or the optical density of the smoke go (sic) up. Now this is one fire growth curve. Now let's say by one way or another we are able to reduce fire growth.

Now, the question now becomes what is inhibiting us from getting out of the mine. Let's say, for example, the major barrier for getting out of the mine safely is the optical density of the smoke.

So basically this is our criterion in terms of optical density. Well, you can see now with this fire growth curve versus this fire growth, if we reduce the fire growth, here is our time saved.

So now we have been able translate a change in fire growth into time, and now we can do a comparison of that time with the other times that we have.

Now, I will show you something else, too, that is kind of interesting. Let's say, for example, that we have been able to implement lifelines. So now the optical density of the smoke is no longer our limitation to escaping. We are not wearing self-rescuers yet. I will deal with that later.

And now our limitation basically is the carbon monoxide concentration that prevents us from getting out. Now essentially you can see if we implemented lower fire growth rate, and we have implemented lifelines, and instead now we can go to the carbon monoxide level, and our time saved is this.

So now we see some sort of synergistic effect between the implementation of lifelines, and we can now use the CO criterion instead of the optical density criterion, and we have seen a synergistic effect between that and the fire growth rate.

Usually when people use the word synergy, I roll my eyes and think that they are blowing smoke, but in this case, in fact we are seeing something in the way of something that could be called a synergistic effect.

Now a little more complicated for leakage, but nonetheless reasonably straightforward -- and I apologize for this because now is on the Y-axis, and I changed the curve around.

And I am plotting leakage versus time from the start of the fire, and I am implying that leakage model that I showed you earlier that I talked about and told you to remember.

And essentially what this says now is that if our leakage is 10,000 CFM, we have roughly 20 minutes before you lose visibility. If the leakage is 2,000 CFM, we have 29 minutes before we lose visibility.

Now what we have been able to do is we have been able to say, oh, if we can reduce leakage from 10,000 to 2,000, we have saved nine minutes before we run out of visibility.

So we have now succeeded in converting stopping leakage into time, and so we can compare the impact of stopping leakage with these other things that we have converted to time as well. Now let's implement lifelines.

DR. WEEKS: Let me ask a question at this point. Suppose there is a fire, and there is leakage. You have got a choice. You might fight the fire, or you might escape, or you might stop the leakage. I think stopping the leakage is pretty far down the list. And if there is a fire, there is a chance that the --

DR. KISSELL: Well, we are not talking about stopping the leakage after the fire takes place. We are talking about building better stoppings.

DR. BRUNE: Or you could talk about closing a door.

DR. KISSELL: Pardon me?

DR. BRUNE: You could talk about closing a door.

DR. KISSELL: Yes.

DR. BRUNE: And that would be an immediate impact on stoppage.

DR. KISSELL: We are talking about basically better stoppings constructed right from the start. But suppose, for example, that we have employed lifelines.

Now that we have lifelines, we don't have to worry so much about the smoke visibility problem, and

I establish here rather arbitrarily 160 part per million CO criterion, with a visibility of 1.6 feet, and here is that criterion right here.

Now with the implementation of lifelines, even with a 10,000 CFM leakage, we have gained 15 minutes here before we reach the 160 part per million CO criteria.

So we can essentially say now with lifelines that we have bought 15 minutes. With lifelines, and lower leakage, we have bought a lot more than 15 minutes.

DR. MUTMANSKY: Fred, there is one thing wrong with that. When you are walking out of the mine, and the smoke becomes thick, and you start using your lifelines, before you do that, you are likely to put the SCSR on immediately.

And that curve right there is not going to help that miner, and his decision making is probably going to be made the moment he sees billowing smoke or whatever it happens to be.

DR. KISSELL: Yes, but what this says is that he can get a lot further outby before he ever sees smoke.

DR. WEEKS: Oh, okay. I understand. My fault.

DR. MUTMANSKY: He is buying time.

DR. KISSELL: That is the whole story here, is buying time, right. We can see from this curve also basically the 60 minutes that are available. And down here, I have not assumed that we have used the self-rescuer yet, and I have assumed now with the self-rescuer that essentially we have 60 minutes available from lifelines in combination with the self-rescuer.

So essentially we have bought 20 minutes originally at a high leakage rate, and another 60 in combination with lifelines in combination with a self-rescuer. So what we have done here is essentially convert all of these things to time.

DR. BRUNE: Excuse me, but let me go back one slide, please. How do you come up with the 60 minutes from lifelines with SCSR? Shouldn't that be going to the black curve on the top there?

DR. KISSELL: That is the fifteen hundred part per million CO criterion.

DR. BRUNE: Yes, and how do you come up with this -- are you saying 60 minutes is because the SCSR has 60 minutes time?

DR. KISSELL: Yes.

DR. BRUNE: Okay. Thank you.

DR. KISSELL: That's it. I'm sorry that I didn't make that clearer.

DR. WEEKS: But that is from the time that you put it on?

DR. KISSELL: Yes. I am assuming that you put it on when you hit smoke, and that's right here.

DR. WEEKS: And I think what Jan is suggesting is that you probably would put it on before then.

DR. KISSELL: But let's say you put it on here, here halfway out, you are not going to put it on right at the beginning. I don't think that is a practice for people. And putting it on here halfway out, you would probably lose at least 10 minutes off this.

But frankly that is another issue, too, is what are the guidelines, and when to put on your self-rescuer. In my book, basically the guideline ought to say that when you see smoke, put on your self-rescuer, because if you don't see smoke, you are not going to get much CO.

In fact, until your visibility declines to about four or five feet, you are not going to have much CO. So you can really maximize life on your self-rescuer by waiting.

DR. WEEKS: And that is not a part of the training.

DR. KISSELL: I know. This whole relationship between smoke and CO is something that is really not been appreciated very much. Now that people have died as a result of getting lost in smoke, and it is very apparent that has happened, there is more understanding of this.

But it is just a shame that that had to happen before people moved on it.
It is very unfortunate. Anyway, I have been able to translate into time a number of factors.

DR. WEEKS: Just a thought.

DR. KISSELL: Sure.

DR. WEEKS: Part of the potential doctrine about training for CO is that it is odorless and colorless, and you can't protect against it, which paramounts against the direction in which you are headed, which is look for smoke, but look for something that is visible. But I would say that should be deemphasized.

DR. KISSELL: I would promote that, yes, but basically what you have learned as a youth or earlier on in your career, is hard to change. You see, the other thing that has happened is that mine rescue teams have gone in after fires, a couple of days later, and essentially they have run into virtually no smoke and high CO levels.

And so my contention that there is a relationship between CO and smoke, and CO level is very low at considerable density, smoke densities, goes against that grain. But if you go into a fire later the smoke has settled out.

I think if you filled this room with smoke, it would be settled out in an hour or two. Fairly quickly, but that doesn't help people trying to escape from the mine fire, because the fire is burning when they are on the way out.

DR. WEEKS: If a guy is inside the mine for an hour or more, than the guideline about if there is smoke, there is CO, and if there is no smoke, there is no CO, that is not true.

DR. KISSELL: It falls apart, yes. We are talking about people who are trying to escape, and I have not done any smoke settling studies, and so it may be more than a couple of hours. But clearly it takes place.

DR. MUTMANSKY: Fred, did you actually do Stokes law on smoke particles to see how quickly they would settle?

DR. KISSELL: No, I haven't done that.

DR. MUTMANSKY: I was just going to say that my opinion would be that it would be much longer than that, but I would guess that most of the smoke would be out of the mine anyway due to ventilation movement by the time that anybody went in two days later anyway. So I wouldn't suspect that there would be a lot of smoke still remaining in the mine.

DR. KISSELL: But the CO would be out also.

DR. MUTMANSKY: What was that, Fred?

DR. KISSELL: The CO would be out also, and this comes from the experience of mine rescue teams.

DR. MUTMANSKY: Right. You're right.

DR. KISSELL: And they are going ahead of the ventilation, too.

DR. WEEKS: But if there is some low grade combustion, there is going to be CO.

DR. KISSELL: Yes, and smoke. In fact, you will notice from the thing that I showed you early on in the smoke paper was that there is more smoke in a smoldering fire per unit of CO than there is in a flaming fire.

DR. BRUNE: One more point. I think we need to distinguish between smoke or CO produced from a fire, and CO produced from an explosion. After an explosion, you could probably have at least in my opinion much higher levels of CO without similar levels of smoke.

So this relationship does not hold true, and in an explosion case, I would put on my SCSR immediately.

DR. KISSELL: That's correct. We deal with mine fires here.

DR. BRUNE: Yes.

DR. KISSELL: Okay. Here is what we have done translating into time. The replacement of the thermocouple sensors by CO sensors, 6 to 10 minutes; CO alarm threshold, changing it from 15 to 10 parts per million, three minutes.

Sensor spacing from 2,000 to 1,000 feet, less than five minutes. Stopping leakage, down 80 percent, a rather unrealistic figure. Only nine minutes.

Walking out versus riding out, 5,000 feet, 10 to 20 minutes, depending on the height of the coal. That is a good way to save time. Decreasing the fire growth rate, 75 percent, saved nine minutes. Lifelines without an SCSR, 15 minutes; with the SCSR, 60 minutes, depending of course when you put the SCSR on.

So what we have done here is we haven't been able to bring in every possible factor, but we have been able to bring in a lot of factors and translate these into time, and make some estimate of the time that we can save if we deal with that particular issue.

Now in the next few slides, I am going to deal with fire growth rate down 75 percent, and talk about this so-called synergy that we saw before. But under the circumstances that we laid out in the initial run, we only saved nine minutes by decreasing the fire growth rate.

DR. WEEKS: Well, just to point out the obvious. The gain that you get is from lifelines.

DR. KISSELL: Yes.

DR. WEEKS: Combined with SCSR?

DR. KISSELL: Yes. Well, yes, lifelines combined with SCSR, and walking versus riding. That is not an insignificant factor, too, especially in relatively low coal.

DR. KISSELL: We are going to look more extensively at fire growth rate, down 75 percent that we saw on the last slide, change, nine minutes. Okay. Now with the lower fire growth rate, our CO alarm threshold, by changing it from 15 to 10 parts per million, now instead of saving three minutes, it saves 12 minutes. And with lifelines and leakage down 50 percent, it saves 56 minutes.

So basically SCSR, in combination with lifelines, aren't really the only way to save considerable amounts of time. A fire growth rate down 75 percent, and leakage down 50 percent, we have got 56 minutes from that with lifelines, not even using a self-rescuer. So there are other ways --

DR. WEEKS: That puts a numerical value on the most primitive question, which is to say fight the fire or leave, right?

DR. KISSELL: Well, basically what happens is that if you are fighting a fire, everybody obviously inby should be moved outby the fire. That is the first order of business, even before fighting the fire.

Our conclusions here essentially from this study and the previous studies is that, first of all, multiple factor changes have the most impact. There is no one single silver bullet that you are going to be able to employ.

The other is that I think you should consider so-called non-technical factors, such as training and management practices, because those impact the delay, and the delay still remains the most significant factor here. That's where I am coming from. Now what is the relevance of these to belt air and belt flammability.

DR. WEEKS: Before we go on, it is a logical extension of your presentation, but kind of outside the boundaries of our this panel's concern, but I didn't see anything about rescue chambers.

DR. KISSELL: I didn't get into that. The research really -- well, rescue chambers were never on the table when I did this research. And I would have to think about that a lot more before I said something.

DR. WEEKS: All right.

DR. KISSELL: What is the relevance of these to belt air and belt flammability? In terms of belt air, the relevance is limited because of other factors.

Forbidding belt air has some serious downsides, particularly with regard to the loss of ventilation quantity and velocity, and will negatively impact methane and dust. So I really didn't deal with belt air at all.

With regard to belt flammability, this is a fire growth rate issue, and I talked I think rather extensively about fire growth rates, and so you can probably get a notion of where that stands with regard to belt flammability. That is really all I had to say. Any more questions?

DR. TIEN: Can you go back to the previous -- maybe three or four slides back? This one and also the diagram. Yes, this one. But what are the assumptions again? Can you revisit that? If we are going to look at this one, can I take this one and use it today?

DR. KISSELL: Sure.

DR. TIEN: What are the parameters? Do you adjust to specific mining conditions, or ventilation systems, or whatever?

DR. KISSELL: This is pretty independent. This is pretty independent, and it essentially derives from that model that you saw back there, where there was a fire in an airway, and leakage into an adjacent airway. This is basically derived from that model.

And essentially depending on the quantity of leakage, it takes a certain amount of time for the visibility to decline to the 12 foot level, okay? And that is really relatively independent of various kinds of mining conditions.

All we are assuming is that there is a fire in an adjacent airway, and that the smoke and fire fumes leak into the airway that the miners are in. That's all. That is the only assumption.

And this is the amount of time right here it takes, and let's say with 4,000 CFM leakage, for it essentially to reach the 12 foot -- here we are, the 12 foot, 3.7 meter optical density value, we run out of visibility, and this is the time here that it takes to reach 160 parts per million at 1.6 foot visibility.

And this is the time that it takes to reach 1,500 parts per million, which is corresponding to a two inch visibility.

DR. TIEN: You have probably answered already most of my second, if not all of my questions, and that is that this table was written in 1993?

DR. KISSELL: In the early '90s sometime, yeah.

DR. TIEN: The '90s. Have any of the things that have happened in the past 15 years where you would want to add or subtract anything from this one?

DR. KISSELL: No, not that I can see. It was based on a fairly straightforward model that I think applies today. Fortunately, the lifelines have been implemented, and self-rescuer training has improved, and I think self-rescuers are better.

So basically things have improved considerably over where they were back in 1990. So that is where the big changes have been, rather than the changes in mining conditions.

DR. TIEN: Thank you.

DR. WEEKS: The other factor that you didn't include is the number of entries, and when we were talking about using belt air ventilation on the face, it is usually associated with the reduction of the number of entries. Did you factor that in?

DR. KISSELL: I didn't. I didn't see any way that I could see through to do that, because basically the model essentially assumed fire in one air way, and leaking into the adjacent air way, and that was the only assumption that I made, which is in some ways sort of a worst case condition. Because if you were two air ways over, then presumably the leakage would be less maybe.

MR. MUCHO: If you could go back to that slide, Fred. Let me interrupt and point something out regarding that.

DR. KISSELL: Which one?

MR. MUCHO: The slide of your model.

DR. KISSELL: All right.

MR. MUCHO: Let's say that entry on the left where the fire is, is a belt entry, and let's say the entry over here on the right side of that stopping line is the intake escapeway.

This presumes that the leakage is from the -- or in this case, the belt into the intake escapeway. In the case of using belt air, we would be pretty assured that our highest pressure entry would be our intake escapeway, and belt entry would be less, and we would have the 50 percent max from the belt entry, et cetera, which would basically dictate that, especially with the resistance of the belt line.

So our leakage would be in the opposite direction. So the intake escapeway air would be clear, but the leakage being also clear. So under this scenario, if it was in the belt entry, we should have a cleanout of escape options?

DR. KISSELL: Right. Until the fire got big enough to throttle the air flow in that air way, and then --

DR. WEEKS: Well, both of those entries blow smoke, and that is your only way out, that's a problem. I mean, unless there is another entry that is clear, you stand a better chance --

DR. KISSELL: We could have established

another entry over here, and the delay time associated with that. I could have done that, but I didn't.

DR. WEEKS: Well, in your spare time, maybe you can. You have spare time now, and --

DR. KISSELL: My nursing home computer I could do that on, yes.

DR. WEEKS: Well, I think that is a factor that should be included in some way or other about the number of entries. It is simple enough. Conceptually it is simple enough. I don't know how simple it is mathematically.

DR. KISSELL: Well, you know, Gary Pittman and I back around this same time tried to get our hands around that issue in some way. I don't know whether it was with a fault tree or some sort of a systems analysis, saying, well, if you run into the smoke, you can go over here, or you can go over here, or you can try this, or you can try that.

And we tried to come up with something. You know, this is reasonably straightforward, and we tried to come up with something straightforward that would lead to some sensible conclusions, and we just went around in circles after a while and gave up after.

It was just too difficult because there are just too many improbables, because it depends on sort of where the fire is, and what decisions are made with regard to go from one entry to another, where the doors are, whether they can find the doors, and after a while we just -- you know, we tend to work on problems that we can solve in a reasonably short time frame, so as to get a paper out and get on to the next issue, if you know what I mean.

DR. WEEKS: Well, you came up with a very primitive estimation of it. You think there is a fire, and you are better off having three entries compared to two to work with, in terms of an efficient escape.

DR. KISSELL: Well, wait a minute now. Where is the fire source, in the intake or the return?

DR. WEEKS: I don't know.

DR. KISSELL: Say a 10 entry system, with just an entry or just an intake and a return, you have a huge pressure between the intake and the return. If you can locate your sources out in the mains so that basically any fire in the mains, for example, leaks into the return, then essentially you can get out under some conditions that have pretty substantial pressures, okay?

So I can visualize scenarios that depending on where you put your fire source, and if the fire source leaks directly into the return rather than coming down the intake, then you have huge pressures between the intake and the return airways, and your escape out is pretty good.

DR. WEEKS: That's all true, but --

DR. KISSELL: It is all factored in what assumptions you make in the beginning.

DR. WEEKS: Well, I understand that. I mean, in the event that you have more than one way out of a mine where there is a fire, that seems to me to be inherently safer than having only one way out.

It is like you have a burning building, and you have two fire escapes, and you can go this way or that way. It is the classic case of having one fire escape blocked and which would prevent you from going out the other way, and a lot of people died because of it if they didn't have another way out.

DR. KISSELL: I would have to simulate it, and I would have to figure out where the fire source was likely to be, and I would have to look at the pressures before I drew the same conclusion.

MR. MUCHO: And the counter to that, Fred, is the Marianna mine, the '58 fire, and the fire occurred in the sub-mains, and we had eight entries there, but the fire occurred in the belt entry, which was the highest pressure and the leakage into the other entries made it very difficult to get the three crews out by the fire area.

And you know the story of the fire and getting them out took some heroics on some people's part, because all of the entries were contaminated. So there you had eight entries, but because the fire occurred at the highest pressure, and because of leakages, everything was contaminated.

DR. KISSELL: Yes. You know, it was once said that for every complicated problem, there is an answer; that it is clear, simple, and wrong. And I would have to simulate it before I believe it, and I have to work out the probabilities, and I would have to look at the starting conditions.

DR. WEEKS: I don't understand your hesitation on this, but I am only making a very simple statement, which is that normally the more ways out the better, rather than fewer.

DR. KISSELL: It certainly seems that way, but if you don't control the pressures, and if you don't control where the fire sources are, it doesn't make any difference. So the first actions would be to control the pressures and control the fire sources. That is sort of where I am coming from. Yes?

DR. GALIZAYA: One question related to the time analysis. Did you do this analysis based on the value of the probabilities, or how exactly did you get this time analysis conclusions?

DR. KISSELL: Basically, what we did is that we did a sensitivity analysis on probabilities. We established a number and put a number in, and then we varied that number and varied the alternative numbers to see whether in fact the results made any sense in a common sense way.

And what we were relying on here in the way of conclusions is not necessarily the values of the probabilities, or even how much we varied the probabilities.

What we were relying on for conclusions is the simple fact that no matter what probabilities we picked, no matter how much we changed the probabilities of any single or small combination, it never made any difference.

Our conclusion was basically that if you want to affect a top event, and if you want to lower the probability of not getting out, you have to affect a whole bunch of things on the bottom.

So to really get down to it, what numbers that we picked for the individual probabilities were not really all that relevant. It is the fact that we could vary them all over the map, one or two all over the map, and it didn't make much difference.

And that is essentially why we concluded that you really have to vary a lot of things. There was no relative comparison, let's say, of CSCRs versus lifelines in the fault tree analysis that we could really depend on, other than the fact that the notion that you sure had to use both. Plus, minimize delays, plus, plus, plus, plus. So we never really relied on any specific probability numbers.

DR. WEEKS: How would you take that message and put it in a form that was readily comprehensible? I mean, you said there is no silver bullet, and just putting it in the negative, but also putting it in the positive?

DR. KISSELL: Well, it sort of depends on how you see your charge on your panel. Are you dealing only with belt fires, or do you see basically some possibility of implementing things that not only deal with belt fires, but deal with fires in general?

DR. WEEKS: Actually, we are not just dealing with fires. What we are dealing with is the whole issue of using the belt air entry at the face, and so it is a little different.

DR. KISSELL: Well, I mentioned before that this particular model, as we said, doesn't deal directly with using belt entries, okay?

DR. WEEKS: That's true, but I am taking the concept as sort of a general concept, and to apply it to a situation. I guess that is an issue for us to decide.

DR. KISSELL: Yes. The problem is that I am here to talk about this particular research, and the research really never dealt with belt air, simply because belt air not only impacts the top event, in terms of escape from mine fires, but it impacts other possible events because of the loss of ventilation air.

You are raising the chance that methane will be higher, and you are raising the chance that dust will be higher. So it is a much more complicated issue than just a straightforward escape issue, and really beyond my capability of handling this in this kind of a model.

So essentially I am not really able to draw much in the way of conclusions about belt air from this topic at all. I am able to draw conclusions about belt flammability, and fire growth rate, which I gave to you.

DR. WEEKS: Could we have a copy of his paper?

DR. KISSELL: I think you have got them. If you don't, I can get them for you. Is that all? If so, thank you very much then.

MS. ZEILER: Thank you, Dr. Kissel. I would like to suggest that we take our 15 minute afternoon break now.

(Whereupon, a short recess was taken.)

MS. ZEILER: All right. Just a couple of items. One, the Aracoma Mine Number One report has been issued, and copies have been given to the technical study panel members.

Panel members will see that there is a disk in the back, and so if for any reason you don't want to haul the entire binder on the plane, we can mail that to you.

The next issue on the agenda is a presentation of comments. The National Mining Association and the United Mine Workers of America were offered a chance to be on the agenda at this meeting to comment on the issues before the panel, and unfortunately the United Mine Workers couldn't make it due to prior commitments.

But Thomas McNider, the general manager for Mining Engineering for Jim Walters Resources is here to present on behalf of the National Mining Association. And for the panel's benefit, he has got hard copies that I will provide to you at the end of his statement. Thank you.

MR. MCNIDER: Good afternoon. Jim Walters Resources and the National Mining Association would like to thank the panel for the opportunity to provide comments concerning the use of the belt air course to transport air to the working face, and the associated belt that is used in conjunction with belt air.

And these comments today are going to be strictly related to monitoring and belt air or belt construction materials. And these comments are limited to the composition and fire retardant properties used only in conveyor belt entries where belt air is used to ventilate the working section.

Jim Walters received approval for his first 101(c) petition for modification of a mandatory safety standard, 30 CFR 75.326, in 1979, at its number four mine.

We have been using belt air successfully at all our coal mines since that time. Contrary to the opinion of others, the industry believes that belt air utilization is safe and is in fact much safer than not utilizing belt air.

Numerous studies in the safe use of this form of ventilation in mines throughout our country have shown that belt air ventilation provides for positive ventilation on the belt, real time monitoring for contaminants, and better utilization of air course that is available for ventilation.

Just like any other facet of mining, belt air must be used responsibly and the safe precautions required where it is used must be adhered to. There has been a considerable amount of discussion in the press and among perceived experts about the Aracoma accident, and how belt air was a contributor to the lack of escape for two miners.

I encourage the panel to study the accident report that was just issued today, and by the State of West Virginia Office of Miner Health and Safety, and Training report prior to coming to any conclusions as to the role that belt air played in this tragic event.

I think you will find that conditions totally unrelated to the use of belt air hindered the miners' escape. Belt air has been studied many times, each with a positive finding, that belt air is in fact safe for use on the working face.

The last such study was completed in 1991 by an advisory committee to the Secretary of Labor, who concluded that ventilation of a working section using air course through the belt entry is safe provided that certain protections are incorporated into its use.

In 1996, MSHA initiated a regulatory process to again review the use of belt air, and promulgate regulations as to its use in coal mines. Jim Walters individually and as part of the National Mining Association, has been involved in each study by commenting on its use and offering our mines as sites to be examined.

Should the panel be so inclined, we again offer our mines so that you can see firsthand the safety benefits we derive using this form of ventilation.

I will now turn to my experience at Jim Walters in the use of belt air, and comment on the various types of belt material that we have used in our mines, and also the monitoring that we use in our mines.

These comments reflect our experience at Jim Walter only. Jim Walters mine wide monitoring. In 1979, Jim Walters was granted its first petition to use belt air to ventilate the working sections.

These petitions required sensitive carbon monoxide sensors to be installed at intervals along the belt, and at other locations linked to a monitoring system that would alert the miners working at the face in the event of carbon monoxide levels rising above designated limits.

Early computer systems for accomplishing this were quickly loaded to levels that caused problems for the systems, resulting in numerous false alarms, and high maintenance costs to keep them operating. Because of this, in 1989, Jim Walters decided to design its own mine wide monitoring system.

The system was designed to take advantage of existing carbon monoxide sensors available on the market at the time, and through cooperative efforts with American Mine Research, and CONSPEC, intelligent carbon monoxide sensors were designed.

These sensors were designed with direct communication to the Jim Walters mine wide monitoring system to eliminate unnecessary interface cards, and it incorporated many new features, such as auto-calibrate and self-testing.

The sensors continued to improve and offer very accurate measurements of carbon monoxide even in areas where air velocity is high. Other devices were designed to allow communication to belt controllers, vacuum breakers, power centers, and so forth, and barriers were developed and improved to allow monitoring in areas of the mine requiring permissible equipment. The system was installed at all of the Jim Walters' mines in 1990 and '91.

Operation. The original system used three personal computers to perform the various functions of monitoring the sensors, distributing real time information, and reviewing real time or historical data.

Several design improvements have been made to the system in the 17 plus years of operation, and yet many of the original components underground are still in service. Some of them are still in their original location without loss of service.

One major improvement in the hardware underground, implemented in 1995, was the design of a totally fiberoptic trunk system. This provides noise immunity and isolation that allowed more locations to be monitored and much more reliable communication under all conditions.

The system has a proven track record, and many of the ideas designed into the Jim Walters system were adopted as standard by other manufacturers of mine wide monitoring systems.

This current system takes advantage of the latest personal computer hardware and software that is used in some pretty impressive performance benchmarks. The system uses an SQL database for storing the information logged by the system, and uses two personal computers operating redundantly to maintain as much uptime as possible in this difficult environment.

It is capable of monitoring 32,000 points. One point is equal to the status to be read from a location underground or on the surface, such as the COPPM value from, say, from the number 23 carbon monoxide sensor, or the state of remote switch number two on wesby belt.

Each point may be configured in the system as to how often it is read or scanned, and with current system loading of approximately 2,500 points, the system reads on all values every 1.5 seconds.

These fast scan times are important to deliver as close as possible to real time information to the control room operator. We have learned through our experience of monitoring everything underground that many times information obtained from equipment can be just as important as the carbon monoxide sensor reading when the operator needs to make a decision during an event.

As a matter of fact, the use of mine wide monitoring systems offers the opportunity to operators to monitor many different functions of their operation, which in-turn enhance the safety of their mines.

System staffing. The system would be ineffective without proper staffing. At Jim Walters, we have trained control room operators who watch the system 24 hours a day, seven days a week. This person is also the responsible party as required by MSHA to track people's movement in the mine, and to remove people in case of an emergency.

There has been quite a bit of talk today about escapeways and escape from the mine, which I think most of you may be familiar with the MINER Act, and there have been quite a few improvements along that line.

The monitoring systems can also be utilized as part of the automated tracking system once it is perfected, also as required by the MINER Act. The control room operators are trained to respond to alarms generated by the system and in detecting conditions that may indicate possible problems before they have a chance to escalate into an alarm condition.

The system allows for the setting of five levels of alerts to the operator, and these lower level alerts are set below regulated values in critical areas so that investigation can begin more quickly.

The system also provides, too, such as graphical representations of sensors or equipment, to help them make quick and accurate decisions. They also have the ability in some cases to control devices underground, such as stopping the conveyors, or removing power from the section.

Staffing also includes at least one carbon monoxide technician for each shift, who has the responsibility of keeping the system calibrated, advanced, and in good operating condition.

They are trained in the operation of the sensors and other hardware, and calibration, and the requirements of the law for installation. I will note that the systems we have installed are not unique to Jim Walters.

While systems are tailored to the environment within which they operate, this practice in the system hardware and software are commonplace among companies that use belt air to ventilate the working section.

Summary. Because many operators use belt air, and many petitions were granted, in 1996, regulations were introduced to eliminate the petition process for belt air and apply a more unified standard to the industry.

Most of the requirements that were imposed by the final regulations adopted by MSHA have been in practice at Jim Walters for 10 years or more. Through the years, we have monitored many different special conditions, used many special sensors, and the system has been scrutinized by many different parties, and under various sets of circumstances, and still is recognized industry-wide as the leader in the monitoring systems.

Now I want to move to fire retardant belt materials. Because of Jim Walters' commitment to safety and the utilization of belt air, we decided to study the use of a belt that was more fire retardant than the commonly accepted 2G belt.

Following the Wheelberg Mine fire in December of 1984, where rubber conveyor belting, which was approved under 2G, was suspected of either being the cause or a contributing factor, it was decided that Jim Walters Resources, Mining Division, should reevaluate its conveyor belt specifications in regard to fire resistance characteristics.

Based on this study, it was concluded that Jim Walters mining conditions required more stringent conveyor belt fire resistant characteristics than are acceptable to meet MSHA's Schedule 2G requirements. Consideration was given to establishing testing criteria based on Jim Walters' mines unique conditions.

However, it was determined that this was not necessary because, one, established standards in other coal mining countries were broad enough to cover our conditions, and, two, new testing criteria would be difficult to ensure compliance with and could be prohibitively expensive.

Therefore, the conveyor belt fire resistance regulations in other countries were studied for applicability to Jim Walters' mines conditions. In reviewing the conveyor belt fire resistance characteristics required by other countries, it was decided that none in their entirety met the requirements of our mines conditions.

However, each had some particular test which were applicable to our conditions. Therefore, it was recommended that all future conveyor belt purchases meet the following recognized fire resistance test.

One, MSHA Schedule 2G, EMNR, which is Canadian specs, or NCB 158 flame test. Two, MNR or NCB 158 drum friction test. Three, NCB 158 propane burner test. Four, the MNR or NCB 158 electrical resistance test.

Jim Walters started using a polyvinyl chloride PVC type belt in late 1983, and this continued until 2001. After the proposed belt specifications were released in March of 1989 by what was then the Bureau of Mines, Pittsburgh Research Center for MSHA, Jim Walters started buying what we referred to as new compliance rubber that met these specifications.

We purchased and used this belt from approximately 1991 until 1997, and I have attached with the comments for our one mine the purchases for each of the different type belts to give you an idea of how much of that we used, and what the different type belts were.

Although both of these belts exceeded 2G requirements for fire resistance and operating characteristics, both type belts created operational and safety issues that led us to return to the 2G belt in 2001. Now I would like to review a few of the operational problems that we encountered.

PVC belt materials, Georgia Duct. This belt was extremely tough when new, but aged rapidly. The older it got, the harder and more brittle it became. The surface would crack and the edge cover would break off. It handles coal well, but rock, which we mine a lot of, pitted the surface, which creates a cleaning nightmare.

Wet coal slurry would be deposited along the conveyor at every idler, drive, takeup, and pulley. This in every case is viewed as a hazardous condition, and required large amounts of manhours to control. This problem resulted in numerous 75-400 violations for accumulations of coal dust.

The belt had little longevity and became hard and brittle with age. When spliced with a mechanical splicer, this belt fared well using nail type flexcose splices, but would not hold well with the staple type, the clipper type splices.

The close proximity in which the staple punched through the material caused a zipper like tearing effect directly behind the splice. This failure would occur without warning.

The belt became so hard and brittle that cutting it for splicing and repair purposes became a major task. Mechanical cutting tools were bad to break off the blades while cutting the belt for splicing.

Utility knives, the most commonly used cutting tool, were very dangerous because of the extreme amount of pressure that had to be applied to this hardened belt.

After the belt was run for a while, and the hardening took place, rolling up the belt off of one installation and reinstalling it into another installation, breaks and splits would occur in the fabric.

The point where the trouting idler meets the flat idler in a top idler frame, the pressure of material weight at this point would create splits that would run length ways down the belt. This caused the belt to split, and to spill material at a rate too intense to allow you to continue to run it.

Large amounts of downtime were incurred while the split portion of the belt was cut out and removed. A large rock went through the split and hung into a trofing frame, hundreds of feet of belt material could be ripped before the problem was found and corrected.

Once the edge cover peeled away the material underneath became a major problem. Strings peeled from the inside of the belt and wrapped themselves around every idler in the entire belt system. Large amounts of production time were lost due to having to shut the belt down to de-string the idlers.

Fenner spinner class. The first impression of this belt was good, but we quickly learned that longevity became an issue with this belt also. This material didn't harden like Georgia Duct, but it did have most of the same problems.

Some of these problems were splice failure, long splits at trofing point, pitted covers, peeling edge cap strings. The spout was much worse than Georgia Duct when it came to length way splitting, but far stronger in retaining mechanical splices.

One feature common to both belts, but not mentioned above, is cover losses. This created problems with mechanical fasteners because there wasn't enough cover to recess the splice, allowing scapers and wipers to grab the fastened edge and tear them from the belt.

None of the PVC belt materials that we used allowed the use of poly based idlers. This combination creates tracking issues and the belt is very abrasive to metal idlers.

Bubble wear was close to double that of a rubber belt. Another problem associated with both types of PVC belt that we used was when the belt would slip in the drive, a white smoke could be driven off that was irritating at very low part per million levels to a person's noise, throat, and lungs, and would not be detected by the carbon monoxide detection system.

It is believed that when the PVC belt is heated to lower temperature levels that hydrogen chloride is the gas that is driven off. New compliance rubber, which is the BELT spec, Georgia Duct rubber. This was a very good belt, with strong thick covers that wear very good.

It handles vulcanized and mechanical splices well. It stands up well to abuse that heavy materials subject it to. It can be cleaned with a variety of different scrappers without damage to the cover.

The major problem with this type of belt is that the chemical makeup of the cover material allows it to retain heat for long periods of time. If this belt is allowed to run out of alignment for any length of time, the shavings that peel off the belt will hold enough heat to create what is referred to as a hot spot.

The floor material under the belt used to transfer coal will begin a combustion process, or it could begin a combustion process, and can spread through a large area of your belt entry, and if undetected could even create a fire.

A carbon monoxide system detected many of these hot spots while using this type belt. And in sharing these observations and experiences, Jim Walters is not trying to be negative concerning the use of a more fire resistant belt, but is attempting to point out the operational problems that only looking at one aspect, fire resistance of the belt material, can create.

One, operational problems as stated above, ultimately lead to safety issues. As new specifications for belt material are developed, the developer of the specification must be cognizant that it does not create a multitude of other problems.

In closing, let me again thank you for this opportunity to present these comments on behalf of Jim Walters and the National Mining Association that utilize belt air to ventilate the working section.

Our collective experience has demonstrated that this is safe, effective means to ventilate underground coal mines so that necessary precautions can be implemented to ensure that mine safety is not compromised by its use.

As you consider the many facets of this issue, we ask that you not view each factor in a vacuum. Rather, it is imperative that you consider the overall safety benefits derived from this ventilation practice, which history has proven can be safely and effectively for the benefit of miner safety. Any questions?

DR. BRUNE: May I can start, Tom. Since you have considerable experience with belts that fulfill the highest specifications -- and in fact I commend you guys to exploring that and going into that. But would you be able to tell us, tell the panel, what the cost factors, what the economic factors were of using belt that was adhering to higher specifications.

MR. MCNIDER: I am not prepared to do that, Jurgen, but we did pay a premium to go to the next standard, I can tell you that, above 2G. Of course, our company, like I said, we were committed to looking at a higher grade belt, and we did it for about 20 years.

I can't tell you exactly what the percentage was, but it was definitely more expensive, and we might be able to get that for you, but I will just have to go back and look at that.

DR. BRUNE: And that would be an excellent comparison. I mean, if that is something that you could get, or at least give us something, because certainly the economic impact of coming to a more stringent belt requirement is something that this panel needs to consider.

DR. WEEKS: Yes, and not only the cost of the belt and its longevity, but at least describe how the belt was splitting and so on, and the durability of the belt.

MR. MCNIDER: We definitely -- I think one of the major points that we are trying to present to the panel is that -- and I think that this came out earlier, that I know that the emphasis is on flame resistant characteristics of the belt, and we looked at flame resistance characteristics of the belt.

But you also, and like Jim said, and like Goodyear pointed out in their presentation, I think you have to take into consideration all of the different parameters -- and whether you can weigh them, I'm not sure, but durability of the belt -- if the belt will not do the job it is intended to do, then we have not accomplished anything.

So we definitely as we look at fire resistant characteristics, we have go to take into consideration will the belt do the job that it is intended to do.

And one thing that did come out in this meeting, and there is a distinct difference, I think, between 600 PIW belt, which maybe a lot of operators, if they are using room and pillar type mining, and longwall mines, in our mines the minimum PIW belt that we use is a thousand PIW.

We actually go stronger than that, and I think that while the manufacturers talked about high PIW belts -- and that was part of the problem that we had when we used a PVC type belt. It would not hold up to the rigorous conditions of how tensile loads, heavy wear of the mining material that was being put on the belts, especially for longwall type installations.

DR. WEEKS: Could you say something about your training of people who are AMS operators?

MR. MCNIDER: I think we could better address that, and my understanding is that you guys may come to Jim Walters again. We do have a rigorous training program, especially now that they are the responsible party.

They have always acted somewhat in that position at Jim Walters, but now they are the responsible party for the mine. So there is periodic training where we go through an exercise with the control room operators, where we go through escape, and we go through the ventilation of the mine.

As a matter of fact, there may be some exercises, and there are other people that can elaborate more on this than I can, that try to make sure that these people are in position to handle an emergency. But we definitely can get into that later on.

DR. WEEKS: When you say you periodically check them, how often does that occur?

MR. MCNIDER: Jim, I don't want to say because I an not what it is right now. I would rather go back and review that. But I know that it is done, but I can't tell you what frequency it is done under.

DR. WEEKS: There is only a portion of the group that is going to be monitored, but I guess I can get the information on that later.

MR. MCNIDER: Right. That is something that we can definitely look into. One of the guys that have been involved in our program for years is Randy

Watts, and I am sure that he can definitely address those, and any questions along those lines.

DR. TIEN: Tom, you have been using belt air since 1979 or 1980, or thereabouts?

MR. MCNIDER: Yes, 1979.

DR. TIEN: In the course of 28 or 30 year or so, were there any reportable or non-reportable, or anything at all, on the -- well, what kind of learning curve would you provide other mines?

MR. MCNIDER: Well, we certainly had instances where we have had or where we had sensors that would alarm, and with early detection, where we knew early on, and that to me is one of the biggest important factors in using an AMS system, and making sure that the AMS system is designed and will do what it is intended to do.

I guess one thing is that everybody thinks about the CO sensor, which is the main primary function of the AMS system, but to me it gives you a lot more capability than that. You can monitor flip sequence, switches, land mines which tell you if materials are falling off a belt.

It can tell you if a belt is running or not running. As a matter of fact, you could turn the belt on and off if you had to. If you had an event, you can go back, and under the historical program, you can retrack and learn a tremendous amount of information from the computer program that has stored that information.

Where did the CO originate, and how fast did it travel, how quick did the alarm go off, and those type of things. You can really go back and review the information, and the knowledge that you can gain from this is tremendous.

The other side of the point that I was trying to make is not only do you have the safety of the CO sensors, but you can also tell if a belt has a problem, and what the problem is with the belt. Did a remote take it out, or did something happen around the drive area. Is the belt slipping. There is a lot of information that you can gather using a monitoring system.

DR. TIEN: Can you also share with us -- well, you have, of course, two mines in operation, and in each mine you have how many faces?

MR. MCNIDER: One at each mine, and three continuous miner sections.

DR. TIEN: Right. So you have three development units. Can you share with us what kind of a ventilation system in your mines, and was it developed while you were doing that, and the pressure drops, and the whole nine yards.

MR. MCNIDER: Yes. On a typical miner section, our longwall panels now are typically 12 to 15,000 feet long. We run a split ventilation system belt on the intake, with a primary intake, and two returns.

Typically -- and I am going through this a simple way where I can do it in my head, but on an intake, we have an R per thousand of about .2. So if you go up 10,000 feet, that is an R-2, and on the return, if we have a typical resistance of about .3, and so R per thousand, and if you went 10,000 feet, that is an R of about 3.

And typically as we develop a panel, once we get out to about 10,000 feet, we would have 125,000 cubic feet per minute at the mouth of the section, and about anywhere from 60 to 80,000 across the last open crosscut on the section.

So if you said you had a hundred-thousand in each entry, then that gives you a pressure drop on the section of about five inches, not taking into consideration anything -- any consideration like face drops and that sort of thing.

So for a 10 to 15,000 foot long panel, you would be looking at a pressure drop probably in the range of maybe -- and I am going to back up a little bit, but depending -- and actually the intake dropped a little less than what I said, but it is about 4-1/2 inches, up to as high as maybe six to seven inches on the high side.

After we develop, we connect up, and then for our longwalls, what we do is we pull the yield builder at Jim Walters. In other words, the belts at the number two entry, it is facing that entry.

Our track is intake, and so the air is taken down the track and the belt, and I know that NIOSH referred to use of the outside entry. Well, that is possible to parallel it on the longwall, but then you have to also take in some things, such as de-gassification.

You may have a de-gas line that runs in that entry that has de-gassed the next panel, and so you have to be cognizant, and you might be able to use it, and you may not be able to use it.

But then we take air up, and across the longwall panel, and we are required a minimum of 55,000 on our longwall. We go across the face, and then back to the tailgate to the bleeders, and up the headgate to the bleeders, and then the tailgate typically is on intake, and then the air comes back and is returned out the other entry.

That is typically the way that the sections are ventilated and the longwall.

DR. TIEN: For that kind of a setup, what kind of a gas emission are we talking about roughly?

MR. MCNIDER: Well, Jerry, we have been doing -- I can tell you that in the early days that belt air was -- one of the things that you definitely had to consider about belt air in my opinion was keeping a positive ventilation on the belt, because you have got to be -- well, keeping a primary control on the belt is important, and if you have dead spots trying to take the air to a return, you have got to be extremely careful about being able to keep that in control.

Because if you don't, and if you have got a belt, or if you have got a high gas liberations, then you could have an area that could get into a danger zone with methane fairly easy.

But maintaining a positive flow on the belt in my opinion, one, it helps you from the point of view of the ventilation and getting more air to the face like he said, and he was right, because as you look at the leakage factors, you can't say that you just are at an entry and it is the same thing, because really it is not.

And of course that is just looking at pure ventilation, and that is not looking at the strata control aspects of it, too. But I guess the beauty of in it from our point of view is that -- and you asked about the methane liberation, and I am getting away from that, but our mines back when I first started, they would liberate in the range of 20 million cubic feet per day for the mine.

Today, we are much, much less than that. But we still are gassy enough to where we need -- you know, we are required behind the line curtain 20,000 cubic feet of air, and to do that, you have got to have enough ventilation to get -- if you have 20 behind the line curtain in certain instances, you can double that because of leakage.

So that is 40 to 50 that you have got to have in the last open crosscut. And then when you get back into the section return, you can at least double that again, and if you go 15,000 feet, you are going to probably triple that.

So really now as you look at the big picture, we don't have the gas, but if you look when we are cutting the coal, you still need 18 to 20,000, which means you are still back in this same criteria as far as the amount of air you have got to deliver.

One other thing along those lines. When you talked about horsepower earlier, when I told you about the section pressure, five to six inches for panel development means that you have got to have a lot of horsepower on the surface to move that kind of ventilation.

And we have 3,5000 horsepower fans, and now a lot of that has to do with our depth, and not everybody has to set up that kind of condition, and also how far you keep your shafts in the mine design.

So I am just telling you what Jim Walters does, and those fans are operated at about 1,125,000. So that gives you a little bit of the framework, and why we were moved in the direction that we were.

DR. TIEN: Well, this is not directly related, but I am just curious as to how much you put on the miner unit, quantity wise?

MR. MCNIDER: On the miner, we are required about 18,000 behind the line curtain, but we typically run 50 to 60,000 in the last open crosscut.

MR. MUCHO: What do you run in total water gauge on the main fans? It has been a while since I have been there, and I know what you used to run, but

I am wondering what you are doing these days?

MR. MCNIDER: It still runs anywhere from 15 inches or above.

DR. GALIZAYA: This is regarding the AMS system. You mentioned 25,000 --

MR. MCNIDER: 2,500.

DR. GALIZAYA: 2,500. Out of this, what percentage is for CO sensors?

MR. MCNIDER: Right. We can talk more about that later. I would say that the bulk is for CO sensors. We do a little bit where I told you that we do monitor some other parameters associated with the belt.

We monitor our fans. I think we monitor pumps. But the bulk of it is for -- our primary usage is for the CO sensors, and what is associated with belt air.

DR. GALIZAYA: Do you do monitoring cross-checks on shifts, or what exactly is your cross-check monitoring?

MR. MCNIDER: Well, you know, you would have on-shift, pre-shift, and each person has to have a CO and a methane monitor. So I guess that would be your cross-check, but we also are required to calibrate the sensors, and like I said, we have a guy where 100 percent that is his job, is maintaining the CO monitoring system. It is a technician, one per shift, and their job is to periodically go and pick certain sensors that they calibrate, and check the accuracy.

DR. BRUNE: Tom, is that each person in the mine carrying a CH4 and a CO sensor?

MR. MCNIDER: No.

DR. BRUNE: Each foreman?

MR. MCNIDER: No, that would be a foreman or a fire boss.

MR. MUCHO: Just on the issue of CO sensors. It is pretty easy to tell when they start to go a little bit wacky, right? I mean, you have them in the line, and one is not reading the same as the one before or the one after.

MR. MCNIDER: Right.

MR. MUCHO: And a lot of times when they have started to experience some sort of problem and they are out of calibration, they tend to go way off scale.

MR. MCNIDER: Right. Well, you have COs downstream.

MR. MUCHO: And it is pretty easy to see if you might have a bad sensor or something is out of calibration.

MR. MCNIDER: Right. One thing that I think they can talk about -- and Randy Watts is our guy responsible for that, and he can talk a lot more intelligently about it than I can. But my understanding is that CO sensors have come a long ways since the early days, and the monitoring systems have come a long ways since the early days. Any other questions?

DR. GALIZAYA: How long do they last, each sensor?

MR. MCNIDER: I really can't say. I would prefer to wait and -- well, I can't tell you off the top of my head.

MS. ZEILER: If there are no other questions, thank you very much, Tom.

MR. MCNIDER: All right. Thank you.

MS. ZEILER: I have the hard copies to distribute to the panel.

DR. MUTMANSKY: Okay.

MS. ZEILER: I think we are at the point now where we have public input, but I don't believe we have any signed up do we? Okay. Then I defer to the panel, and if you wish to discuss anything further today.

DR. MUTMANSKY: On behalf of the panel, I would like to thank our speakers today. We really appreciate the fact that you came here to share your knowledge with us, and we thank you.

We will probably -- I think our -- I don't see any reason for us to at this point in time continue the meeting unless you have a reason, Linda.

MS. ZEILER: No.

DR. MUTMANSKY: I will then essentially say we will get back together at 9:00 a.m. tomorrow. Are there any other procedural matters for tomorrow that you want to discuss, Linda?

MS. ZEILER: No, I think that's it. Nine o'clock tomorrow. Great. We stand adjourned.

DR. MUTMANSKY: Thank you.

(Whereupon, at 4:14 p.m. the meeting in the above-entitled matter was adjourned, to reconvene at 9:00 a.m. on Friday, March 30, 2007.)

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REPORTER'S CERTIFICATE

DOCKET NO.: --

CASE TITLE: TECHNICAL STUDY PANEL

HEARING DATE: March 29, 2007

LOCATION: Coraopolis, Pennsylvania

I hereby certify that the proceedings and evidence are contained fully and accurately on the tapes and notes reported by me at the hearing in the above case before the United States Department of Labor, Mine Safety and Health Administration.

Date: March 29, 2007

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